BULLETIN

OF THE

IMPERIAL INSTITUTE

Edited by the Director

VOL. VI

1908

PUBLISHED IN QUARTERLY NUMBERS—TO BE OBTAINED FROM THE FOLLOWING AGENTS

London . . .	Messrs. EYRE & SPOTTISWOODE, LTD., East Harding Street, Fleet Street, E.C., and 2, Victoria Street, Westminster, S.W.
	Messrs. G. STREET & CO., Ltd., 30, Cornhill, E.C.
	THE IMPERIAL INSTITUTE, South Kensington, S.W.
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ERRATA

Page 116, lines 24 and 37,	*for* Eroidendron *read* Eriodendron.
,, 188, line 20,	*for* Upper Perak *read* Singapore.
,, 221, ,, 42,	*for* Minerals *read* Minerais.
,, 335, ,, 24,	*for* Lands election *read* Land Selection.
,, 338, ,, 22,	*for* Australia *read* Australasia.

Richard Clay & Sons, Limited, London and Bungay.

BULLETIN OF THE IMPERIAL INSTITUTE

VOL. VI, 1908

CONTENTS

THE IMPERIAL INSTITUTE

OF THE

UNITED KINGDOM, THE COLONIES AND INDIA

THE Imperial Institute was erected at South Kensington as the National Memorial of the Jubilee of Queen Victoria, by whom it was opened in May 1893.

The principal object of the Institute is to promote the utilisation of the commercial and industrial resources of the Empire by arranging comprehensive exhibitions of natural products, especially of the Colonies and India, and providing for their investigation and for the collection and dissemination of scientific, technical and commercial information relating to them.

Until the end of 1902 the Imperial Institute was managed by a Governing Body, of which H.R.H. the Prince of Wales (now H.M. the King) was President, and an Executive Council, including representatives of the Indian Empire and of all the British Colonies and Dependencies. In 1900 the building became the property of H.M. Government, by whom the western portion and galleries were leased to the Governing Body of the Imperial Institute, the greater part of the eastern and central portions being assigned, subject to rights of usage, for occupation by the University of London. In July 1902 an Act of Parliament was passed transferring the management of the Imperial Institute to the Board of Trade, assisted by an Advisory Committee including representatives of the Colonies and India, as well as of the Colonial and India Offices, the Board of Agriculture, and the Board of Trade. This Act took effect on January 1, 1903.

On October 1, 1907, in virtue of an arrangement made with the Board of Trade and with the approval of the Secretary of State for India, the management of the Imperial Institute was transferred to the Secretary of State for the Colonies, subject to the responsibility of the Board of Trade under the Act of 1902. A Committee of Management of three members, one nominated

by each of the three Government Departments chiefly concerned, has been appointed, and at present consists of the Right Hon. Sir Cecil Clementi Smith, G.C.M.G.; Sir Alfred Bateman, K.C.M.G.; and Colonel Duncan Pitcher (late Indian Army).

The first Director of the Imperial Institute was Sir Frederick Augustus Abel, Bart., G.C.V.O., K.C.B., F.R.S., who held the office until his death in the autumn of 1902. The present Director is Professor Wyndham Dunstan, M.A., LL.D., F.R.S., who was appointed in 1903.

The staff of the Imperial Institute includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology, in their relation to agriculture and to the commercial utilisation of economic products.

The following are the principal Departments of the Institute.

Colonial and Indian Collections.—The Collections of economic products, etc., illustrative of the general and commercial resources of the Colonies and India, are arranged, together with other exhibits, on a geographical system in the public galleries of the Imperial Institute.

The following British Colonies and Dependencies are represented by Collections—

Canada, Newfoundland; Jamaica, Turks Islands, British Honduras, British Guiana, Bahama Islands, Trinidad and Tobago, Barbados, Windward Islands, Leeward Islands, Bermuda Islands; Falkland Islands; New South Wales, Victoria, Queensland, Tasmania, South Australia, Western Australia, New Zealand; Fiji; Cape of Good Hope, Natal, Transvaal, Orange River Colony, Rhodesia, Nyasaland, St. Helena; Gambia, Sierra Leone, Gold Coast, Northern Nigeria, Southern Nigeria; British East Africa, Zanzibar and Pemba; Uganda; Somaliland; the Anglo-Egyptian Soudan; Malta; Cyprus; Ceylon; Hong Kong; Mauritius; Seychelles; Straits Settlements and Federated Malay States; and India.

The Colonial and Indian Collections are open free to the public daily, except on Sundays, Good Friday and Christmas Day, from 10 a.m. to 5 p.m. in summer, and from 10 a.m. to 4 p.m. in winter.

Special arrangements are made for the conduct of schools and institutions desirous of visiting the Colonial and Indian Collections for educational purposes.

A stand has been opened in the centre of the main gallery to facilitate the supply of general information and the distribution of literature. Pamphlets, circulars, handbooks, etc., containing information relating to the commerce, agriculture, mining, and other industries of the principal British Colonies, and also to emigration, are available for gratuitous distribution or for sale. The publications of the Emigrants' Information Office, established by the Colonial Office, may also be obtained. The principal Colonial and Indian newspapers may be seen on application. An officer of the Institute is in attendance at this stand, which is in telephonic communication with the Departments in the main building.

In 1908 the public galleries were visited by 110,189 persons, and 10,196 Colonial and Indian publications were distributed.

A Report by the Director on the Work of the Imperial Institute in 1906–7 has been presented to Parliament (Cd. 3729–48).

The Scientific and Technical Department.—The research laboratories of this Department, which occupy the second floor of the Imperial Institute, were established in order to provide for the investigation of new or little-known natural products from the Colonies and India and of known products from new sources, with a view to their utilisation in commerce, and also to provide trustworthy scientific and technical advice on matters connected with the agriculture, trade and industries of the Colonies and India.

The work of this Department is chiefly initiated by the Home and Colonial Governments and the Government of India. Arrangements have been also made by the Foreign Office, whereby British representatives abroad may transmit to the Department for investigation such natural products of the countries in which they are appointed to reside as are likely to be of interest to British manufacturers and merchants.

Materials are first investigated in the research laboratories of the Department, and are afterwards submitted to further technical trials by manufacturers and other experts, and finally are commercially valued.

Except under special circumstances investigations are not undertaken for private individuals.

A Reference Sample Room is maintained in this Department, in which are arranged samples of the principal materials which

have been investigated and valued commercially during recent years, and as to which full information is available.

The Scientific and Technical Department works in co-operation with the Agricultural and Mines Departments in the Colonies, whose operations it supplements by undertaking such investigations and inquiries as are of a special scientific and technical character connected with agricultural or mineral development, as well as inquiries relating to the composition and commercial value of products (vegetable and mineral) which can be more efficiently conducted at home in communication with merchants and manufacturers, with a view to the local utilisation of these products or to their export.

A very large number of reports on these subjects have been made to the Governments of the Colonies and India, a first instalment of which has been printed in a volume of *Technical Reports and Scientific Papers*, published in 1903, whilst a selection of the later reports has been printed in the *Bulletin of the Imperial Institute.*

Mineral surveys, under the supervision of the Director of the Imperial Institute, and conducted by Surveyors selected by him, are in progress in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland, and preliminary arrangements of a similar nature have been made in connection with British East Africa and with the Anglo-Congolese Boundary Commission in Uganda. All minerals found which are likely to be of commercial importance are forwarded to the Imperial Institute, where they are examined and their composition and commercial value ascertained. Reports by the Director on the results of the mineral exploration in Ceylon, Northern Nigeria, Southern Nigeria, and Nyasaland have been printed in the Miscellaneous Series of Colonial Reports.

In connection with the operations of the Agricultural Departments in West Africa, and with a view to correlating their work and that of the Imperial Institute, an Inspector of Agriculture for British West Africa (Mr. G. C. Dudgeon) has been appointed, who visits West Africa each year, and on his return has his head-quarters at the Imperial Institute.

African Tropical Service Course.—A course of instruction in certain specified subjects is now given at the Imperial Institute to candidates selected by the Colonial Office for administrative appointments in East and West Africa.

Instruction in the subject of tropical cultivation and products in this course is given by members of the Staff of the Imperial Institute.

Library and Reading-Rooms.—The library and reading-rooms of the Imperial Institute contain a large collection of Colonial and Indian works of reference, and are regularly supplied with the more important official publications, and with many of the principal newspapers and periodicals of the United Kingdom, the Colonies and India.

The library and reading-rooms are on the principal floor, and admittance to them is obtained through the entrance at the west (Queen's Gate) end of the building. These rooms are available for the use of Life Fellows of the Imperial Institute, and of other persons properly introduced. Books and newspapers may be consulted for special purposes by permission.

Colonial Conference Rooms.—Three rooms, specially decorated and furnished, are reserved on the principal floor for use by representatives of the Colonies for meetings and receptions.

The Cowasjee Jehanghier Hall.—The Bhownagree corridor and rooms in connection with this Hall are in the occupation of the Indian Section of the Imperial Institute, whilst the Hall is available for lectures, meetings, etc.

The "Bulletin of the Imperial Institute" is published quarterly, price one shilling (annual subscription 4*s.* 8*d.*, including postage), and may be purchased at the Imperial Institute or from Messrs. Eyre and Spottiswoode, Ltd., East Harding Street, Fleet Street, London, E.C., or from agents in the Colonies and India. The *Bulletin* contains records of the principal investigations conducted for the Colonies and India at the Imperial Institute, and special articles chiefly relating to progress in tropical agriculture and the industrial utilisation of raw materials (vegetable and mineral).

The following Societies have their head-quarters at the Imperial Institute—

British Women's Emigration Association.—The British Women's Emigration Association has been assigned an office on the first floor, which is open daily from 10 a.m. to 4 p.m., and

advice and information respecting emigration and prospects for women in the Colonies may be obtained there free of charge. This Association works in co-operation with the Emigrants' Information Office in Westminster.

Colonial Nursing Association.—This Association has been assigned an office on the first floor of the Imperial Institute. Its principal object is the selection of trained hospital and private nurses for service in the Crown Colonies and other British Dependencies.

African Society.—This Society, which is concerned with the discussion and publication of all matters connected with British African Possessions, has been assigned an office on the Mezzanine floor, and holds meetings at the Imperial Institute for the discussion of African questions. The *Journal of the African Society* is published quarterly.

THE IMPERIAL INSTITUTE

STAFF.

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N. C. Akers, A.I.C.
G. M. Davies.

Mineral Surveys.

Mineral Surveys of Ceylon, Southern Nigeria, Northern Nigeria and Nyasaland are being made under the supervision of the Director of the Imperial Institute by the following officers, the chemical investigation and valuation of the minerals collected by the Surveyors being conducted at the Imperial Institute. Preliminary surveys have also been undertaken in British East Africa and Uganda.

Ceylon: J. Parsons, B.Sc. (Lond.), F.G.S.
J. A. Daniel, B.A. (Cantab.).

Southern Nigeria: A. E. Kitson, B.A. (Melbourne), F.G.S.
E. O. Thiele, B.Sc. (Melbourne).

Northern Nigeria: J. D. Falconer, M.A., D.Sc. (Edin.), F.G.S.
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Nyasaland: A. R. Andrew, B.Sc. (N.Z.), F.G.S.
T. E. G. Bailey, B.A. (Cantab.).

Uganda: J. E. Coates, B.A. (Cantab.) (*attached to the Anglo-Congolese Survey Commission*).

British East Africa: K. Joll.

Colonial and Indian Collections.

Technical Superintendents:

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H. Spooner.

BULLETIN

OF THE

IMPERIAL INSTITUTE

1908. Vol. VI. No. 1.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Indian and Colonial Governments concerned.

TEAS FROM NATAL.

In an article on "The Tea Production of the British Empire" in this *Bulletin* (1904, **2**. 206), reference was made to the tea industry of Natal and a table was given showing the areas of land under cultivation and the quantities of tea produced during the years 1880–1902.

The introduction of tea into Natal took place in 1877, when seed was forwarded from Calcutta and was planted as soon as it arrived. The varieties introduced were "Assam Indigenous" from the Rookang Estate, and "Assam Hybrid" from the Longeeburr Estate. The former has been found to be the more suitable, as it produces more leaf and yields a manufactured tea of superior quality. After various disappointments and discouragements, owing to losses caused by drought and the attack of insect pests, no serious attempt was made to extend the cultivation until 1881. Since this time the area under cultivation has gradually increased until it now amounts to about 4,000 acres and yields annually 2,000,000 lb. of the manufactured article.

The samples of Natal tea which are the subject of this report were taken from specimens exhibited in the Natal Court of the Imperial Institute and from supplies forwarded to the recent

South African Products Exhibition in London. The latter specimens were transferred to the Imperial Institute at the close of the Exhibition, and are now shown with other samples in the Natal Court.

At the request of the Natal Government a chemical examination of representative samples has been carried out in order that a comparison of Natal teas with Indian and China teas could be made.

The results of the examination are shown in the following table, which includes for comparison the corresponding figures obtained at the Imperial Institute for Indian and China teas and also for Ceylon green teas.

		Percentages calculated on material dried at 100° C.				
Estate.	Description.	Moisture.	Ash.	Extract.[2]	Caffeine.	"Tannin."[3]
Natal Teas—						
Kearsney	Grade 1[1]	9·1	5·8	26·1	3·9	7·8
,,	Grade 2[1]	7·6	5·6	28·8	3·6	6·3
,,	Grade 3[1]	7·4	5·2	27·4	3·1	6·7
,,	Grade 4[1]	8·7	5·9	25·0	3·4	6·8
,,	Flowery Pekoe	7·6	5·1	not determined		7·0
,,	Broken Pekoe	6·9	5·8	not determined		7·3
Barnsdale	Pekoe	5·96	5·8	26·2	4·8	10·5
Clifton	Pekoe	6·2	4·8	31·4	not determined	13·0
Barnsdale	Golden Pekoe	5·5	5·5	28·0	4·4	11·5
,,	Flowery Pekoe	6·1	5·3	27·0	4·2	11·6
Aroma	Pekoe Souchong	7·1	5·5	24·3	4·0	10·4
,,	Fine Natal Souchong	8·0	5·0	20·9	4·1	10·1
Barrow Green	Souchong	7·7	5·2	33·0	4·4	10·8
	AVERAGE	7·1	5·4	27·1	4·0	9·2
Indian Teas (13 samples)—						
	Maximum	7·8	6·9	35·2	4·1	11·1
	Minimum	6·4	5·4	27·4	3·6	6·9
	AVERAGE	7·1	6·0	31·7	3·8	9·2
China Teas (8 samples)—						
	Maximum	9·2	8·2	27·2	3·7	9·3
	Minimum	7·1	6·0	19·0	2·6	3·3
	AVERAGE	8·2	6·8	24·3	3·0	5·2
Ceylon Green Tea—						
	No. 1	6·7	2·6	24·5	2·9	14·5
	No. 2	6·2	5·0	35·0	2·9	16·6
	AVERAGE	6·5	3·8	29·7	2·9	15·5

[1] *These four samples were taken from specimens in the Natal Court of the Imperial Institute; the remainder were from the South African Products Exhibition.*

[2] *"Extractive matter" or "extract" is the percentage dissolved by treating a given quantity of the tea with one hundred times its weight of boiling water, and allowing it to infuse for ten minutes.*

[3] *Determined by Procter's modification of Löwenthal's process.*

Conclusions.

A consideration of the foregoing analytical figures shows that these Natal teas may be divided into two groups, which differ considerably in composition: (1) those from the Kearsney Estate, and (2) those from all other sources.

The specimens from the Kearsney Estate, grades 1 to 4, were all good black-looking teas, containing from 3·1 to 3·9 per cent. of caffeine and from 6·3 to 7·8 per cent. of tannin. The other two specimens of "Flowery Pekoe" and "Broken Pekoe" from the same source also contained a low percentage of tannin, *viz.* 7·0 to 7·3 per cent. These figures must be regarded as very satisfactory, since the average percentage of caffeine (3·5) is only a little below the amount present in the Indian teas examined, and on the other hand the average amount of tannin (7 per cent.) is considerably lower. In respect of the percentage of tannin these teas from the Kearsney Estate are intermediate between the Indian and China teas. The amount of extractive matter is also less than in the Indian teas, and approximates to that of the China samples.

As is well known, it is the caffeine to which the valuable stimulating properties of tea are due, whilst the presence of much tannin is generally considered to be detrimental.

The other group of Natal teas, comprising all the remaining specimens, is characterised by unusually high percentages of caffeine and tannin. The amount of caffeine ranges from 4·0 to 4·8 per cent., with an average of 4·3 per cent.; whilst the percentages of tannin vary from 10·1 to 13·0 with an average of 11·1 per cent. The abnormal amount of tannin (13 per cent.) present in the Pekoe tea from the Clifton Estate is probably due to the fact that the sample had not been properly fermented and was more or less green. So far as the amount of extractive matter is concerned, this group agrees closely with the Kearsney teas.

The difference in the figures furnished by these two groups of specimens is very striking, and may be due to some modification in the processes of manufacture.

It was to be expected that Natal tea would show a general similarity to Indian tea, since the original seed was obtained

from Assam. This similarity can be seen in the figures for the majority of the specimens and in the average results, but in the case of the Kearsney teas the small percentages of extractive matter and tannin approximate more nearly to those obtained for China teas.

These results show that the cultivation of tea in Natal and its preparation deserve very full study with a view to the production of a tea of characteristic quality. The best of these teas combine the qualities of the teas of China and India.

FLAX FROM NEW SOURCES.

SEVERAL samples of flax from various countries have been examined recently in the Scientific and Technical Department of the Imperial Institute, and the principal results have been incorporated in the following account.

FLAX FROM CYPRUS.

A small bale of flax straw from which the seed had been removed, and a similar quantity of the fibre which had been retted in the Island, were forwarded for examination by the Director of Agriculture.

I. *Flax Straw.*—This sample of flax straw, which had been retted but not broken and scutched, was straight and but little branched. The colour was pale brown or greenish-yellow, and the length varied from 18 to 28 inches. The fibre was fairly easily separated by hand from the straw.

On comparing the sample with a standard sample of flax grown in Belgium, the following results were obtained :—

	Flax Straw from Cyprus.	Flax Straw from Belgium.
Length of Straw .	18 to 28 inches.	30 to 36 inches.
Diameter of straw—		
Maximum . . .	0·068 inch.	0·064 inch.
Minimum . . .	0·003 „	0·032 „

It will be seen from the foregoing figures that the flax straw from Cyprus was shorter than the standard Belgian sample used

for comparison, but that the maximum and minimum diameters were approximately the same. The sample from Cyprus, however, contained a larger proportion of fine straw.

II. *Flax Fibre.*—This sample consisted of flax fibre obtained after breaking and scutching. It contained a quantity of broken straw or "shieve," but most of this could be separated by shaking. The colour was light or greyish-brown, and the length of the filaments or strands of fibre was the same as that of the straw, *viz.* 18 to 28 inches. The strength of the fibre was somewhat uneven, some portions being very weak. This defect suggested that the material had not been uniformly retted.

The following results were obtained on comparing this sample with a standard sample of Belgian flax :—

	Flax from Cyprus.	Flax from Belgium.
Length of strands of fibre .	18 to 28 inches.	30 to 36 inches.
„ „ ultimate fibres .	0·2 to 0·9 inch. (average 0·4 inch)	0·3 to 1·1 inch. (average 0·6 inch)
Diameter of fibres (average)	0·0008 inch.	0·00086 inch.

It will be noticed that the flax from Cyprus contained slightly shorter and finer ultimate fibres than the commercial Belgian sample used for comparison.

Flax represented by these samples from Cyprus would not be suitable for the manufacture of linen cloth. The partially cleaned sample had been very imperfectly scutched, and one end of the straw had not been "broken." For this reason the flax was not in a suitable condition for manufacture, except, perhaps, for rough bagging material. It is probable that the straw could be more perfectly and evenly scutched if it were retted for a slightly longer period. Care should also be taken to ensure that the straw is entirely submerged during the retting process. The difficulty in cleaning one end of the straw may have been due to the bundles having been placed on end with the upper portions slightly above the surface of the water, with the result that the straw had not been evenly subjected to the retting action.

The large quantity of fine straw present in Sample I suggested that the seed had been sown too thickly, and consequently the straw had become attenuated. The quantity grown should be

just sufficient to prevent branching of the straw and at the same time to allow each plant the necessary light and air. It is usual to sow about 3 bushels of seed per acre; if more than this quantity is used, it will probably be found necessary to thin out the young plants.

The commercial expert to whom the sample was submitted reported that the fibre had been ruined for spinning purposes by leaving the ends uncleaned. If, however, the material had been properly prepared, although hard and lacking in "spinning quality" it might have been worth about £20 per ton. In the condition of the sample it could not be used in the linen trade, but might realise £10 to £12 per ton for mixing with common jute for the production of very coarse bagging.

From the foregoing particulars it will be realised that this flax from Cyprus could not compete with Belgian flax for textile purposes, unless the growth could be improved and the cleaning done more efficiently. It was therefore recommended that action should be taken on these lines and further samples submitted for examination and report.

FLAX FROM THE EAST AFRICA PROTECTORATE.

This sample of flax was grown in the Highlands of East Africa at an altitude of about 5,600 feet, and consisted of two bundles of fibre, which had been retted and broken. Most of the "shieve" or broken particles of straw had been removed in the scutching operation, but a small quantity still remained. The fibre was lustrous, greyish-brown in colour, and of fairly good strength. The length of the strands of fibre was 24 to 32 inches, and their diameter 0·0025 to 0·020 inch.

Microscopical examination showed that the fibre had the characteristic structure of flax, and that the ultimate fibres had an average diameter of 0·00056 inch.

The flax appeared to have been over-retted. The fibres could be very easily separated, and consequently an abnormally large quantity of waste would be produced in the processes of manufacture. Fibre of this character is known in commerce as flax codilla. It is the product of over-dew-retted flax straw.

The commercial value of flax codilla of the quality of the sample would be about £26 per ton delivered in Dundee. At

the date of this report (March 1907) this class of material was in considerable demand, and the price quoted was about £3 or £4 above the ordinary value.

The straw from which the fibre was produced would no doubt have furnished with proper treatment the true flax of commerce, and also given a larger yield. Such fibre would be worth from £30 to £35 per ton.

The quality of the sample indicated that further experiments in flax-growing might well be made in the district where this fibre was produced.

FLAX FROM THE TRANSVAAL.

A sample of flax, grown at Potchefstroom, was sent for examination by the Acting Director of Agriculture. The yield of dry straw was stated to have amounted to 966 lb. per acre.

The sample consisted of unretted flax straw, bearing mature seed capsules. The straw had a maximum length of 36 inches, and was hard, woody and much branched. It was exceptionally coarse, the average diameter being double that of good commercial flax straw grown in Belgium.

On retting the straw, a light yellow fibre was obtained which was soft to the touch, of good lustre, but of rather poor strength. Microscopical examination showed the fibres to be fine and regular, and to have the characteristic structure of flax.

It was pointed out that flax straw of this quality would have little commercial value. The chief defects were the branching of the stalks and the presence of an abnormal quantity of coarse woody tissue in the straw. These faults were probably due to the seed having been sown too sparsely.

When the flax plant is grown for fibre, and not for seed, the straw should be gathered before it is fully mature, that is, before the stalks and seed capsules have become entirely brown. If the flax is left to grow until the whole stem is yellow or brown and the seeds are fully ripe, the fibre obtained will be coarse and of inferior quality.

FLAX FROM THE ORANGE RIVER COLONY.

Three samples of flax were forwarded from the Agricultural Department of the Orange River Colony.

Sample No. 1 consisted of unretted flax straw which was hard and woody, much branched, bore a large quantity of mature seed capsules, and varied in colour from green to light brown. The length was very uneven, some of the mature stalks being only 8 inches long, whilst others had a length of 24 inches.

Comparison with a standard sample of Belgian flax straw showed that the sample under examination was much coarser.

	Flax straw from Orange River Colony.	Flax straw from Belgium.
Maximum diameter	0·200 inch.	0·064 inch.
Minimum diameter	0·048 inch.	0·032 inch.

Flax similar to this sample would be of no value as a source of fibre. The chief defects were the branching of the stalks and the presence of coarse woody tissue in the straw. The branching of flax straw and also the presence of hard wood constitute serious defects, which are caused by the sowing of an insufficient quantity of seed. The recommendations made regarding the Transvaal sample apply equally to this one from the Orange River Colony.

Sample No. 2 consisted of 1½ lb. of retted flax straw, which was hard and woody, but less branched than the preceding sample of unretted straw. The flax had been unevenly retted, many portions having been very much over-retted, with the result that the fibres, which had become entirely separated from the straw, were entangled and broken.

The length of the straw varied from 19 to 33 inches. The fibre was greyish-brown and of rather poor strength. The ultimate fibres had a diameter of 0·0003 to 0·0009 inch, with an average of 0·00063 inch.

Sample No. 3 consisted of flax which had been retted and broken, most of the "shieve" or broken particles of straw having been removed. Owing to the straw having been over-retted, the fibre bundles in many cases had become broken up into short lengths from 4 inches upwards.

The flax resembled that obtained from the retted straw of the previous sample.

Samples 2 and 3 were of little or no value for spinning, owing to their having been greatly over-retted.

In perfectly retted flax the fibre will separate from the straw in the form of a ribbon of good strength with all the fibres adhering together, whereas in the samples under examination the fibre bundles have been either greatly weakened or resolved into short fibres by the prolonged steeping in water.

FLAX FROM BENGAL.

This sample, grown from Riga seed at the Bankipore Agricultural Experiment Station, was forwarded for examination by the Director of Agriculture, Bengal, and consisted of two bundles of unretted flax straw.

The straw was straight and generally not branched, except towards the upper parts. The colour varied from green to pale yellow. The fibre could be easily separated from the yellow portions by breaking the straw, thus indicating that the material had become partially over-ripe.

The following results were obtained on comparing the sample with a standard specimen of flax straw grown in Belgium :—

	Flax straw from Bengal.	Flax straw from Belgium.
Length of straw . .	30 to 42 inches.	30 to 36 inches.
Diameter—maximum .	0·132 inch.	0·064 inch.
" minimum .	0·041 "	0·032 "

It will be noticed that the flax from Bengal was longer and coarser than the standard sample of Belgian flax used for comparison.

The clean fibre obtained from the Indian straw had an average diameter of 0·00094 inch, the diameter of the standard sample of Belgian flax being 0·00086 inch. The sample under examination was therefore generally coarser than the Belgian specimen.

The straw was well grown, but it seems probable that insufficient seed had been sown, as a considerable amount of wood had developed in parts of the straw. Advice was given as to the quantity of seed which should be sown per acre, and the age at which the straw should be pulled.

With greater care in cultivation it is highly probable that flax of excellent quality could be grown in that part of Bengal where the present sample was produced.

FLAX FROM BROUSSA, TURKEY.

Two samples of flax were forwarded by H.M. Vice-Consul, Broussa, Turkey, which appeared to have been submitted to a chemical bleaching process.

Sample No. 1.—This consisted of clean white fibre, which was lustrous, smooth to the touch, and much tangled. The length of the staple was irregular, ranging from as much as 10 inches down to 1 inch or even less.

On microscopical examination, the fibres were found to be usually united in bundles of 0·004–0·016 inch in diameter. The ultimate fibres themselves had an average diameter of 0·0008 inch, and exhibited the characteristic structure of flax.

This material appeared to be the short fibre obtained in some preparing or combing process. The longer fibres could be separated from it and spun into a yarn of medium quality, whilst the very short fibres could be used for the manufacture of coarse yarn or as tow.

Sample No. 2.—This sample varied in length from about 12 to 20 inches, and the fibres were straight and parallel to one another. In other respects the product resembled Sample No. 1.

This material consisted of the "tops" or long fibres, which had evidently been straightened and prepared for spinning, and would no doubt furnish a yarn of good quality.

Commercial experts reported that these samples of flax were not of the quality usually met with in the English market, and that they appeared to have been submitted to chemical processes which might have caused injury to the fibre and would be prejudicial to the sale of the material. They expressed the opinion that the product would be saleable in this country, but that the fibre in its unbleached, natural state would probably find a better market.

A further sample of the fiax was forwarded by the Vice-Consul at a later date, which had been retted and broken, but had not been treated chemically. Most of the "shieve" or particles of woody tissue had been removed in the scutching operation, but a small quantity remained in the sample. The flax was pale golden brown, of good lustre and soft to the touch, but of rather poor strength. The fibres varied in length from

22 to 30 inches, and in diameter from 0·0029 to 0·0145 inch. The ultimate fibres had an average diameter of 0·0005 inch.

The fibre from Broussa was similar in most respects to a standard sample of Belgian flax, but was slightly shorter and of inferior strength, whilst many loose fibres projected from the bundles. The two latter defects suggest that the material had been slightly over-retted.

A portion of the sample was submitted to commercial experts, who reported that the flax could be used by spinners of very heavy yarns, but that it was really more suitable for rope-making than for spinning. They stated further that the fibre appeared to have undergone a process of hackling at the ends, and it was feared that a consignment in bulk would not be equal, on the average, to the present small sample.

The commercial value of flax equal to the sample was estimated at £30 per ton in this country at the date of the report (June 1906).

There is no doubt that manufacturers would prefer to receive this flax from Broussa in its natural unbleached condition rather than after it has undergone chemical treatment.

COTTONS FROM INDIA.

THE following is a summary of a number of reports on cottons from India and Burma which have been examined in the Scientific and Technical Department of the Imperial Institute during 1906–07. In cases in which the product was received unginned, it was treated in the Department by means of a Platt's Macarthy gin.

COTTON FROM BENGAL.

1. A sample of cotton, grown in the Singhbhum district of Bengal, where it is known as "Buri Kapas," was forwarded by the Department of Agriculture, Bengal. The plant furnishing this cotton was thought to be *Gossypium arboreum.*

The sample consisted of seed-cotton and contained some

fragments of leaves, and on ginning yielded 28·5 per cent. of cotton.

The cotton varied in colour from pale cream to white with some yellow and brown stains; it was of poor lustre, harsh to the touch, and of a "woolly" character. The fibre was of normal strength, and generally from 0·6 to 0·9 inch in length, although some shorter fibres were also present. The diameter of the fibres ranged from 0·0005 to 0·0010 inch with an average of 0·0009 inch.

On microscopical examination, the cotton was found to be coarse, fairly regular in diameter, and free from immature fibres, but it showed an irregular spiral structure.

The seeds were very small, and were thickly covered with a short brown or greenish-grey down. The fibre was firmly attached to the seeds, and could only be detached by hand with difficulty.

A sample of the ginned cotton was submitted to brokers, who reported that in appearance it was about equal to "strict fully good fair ginned Bengal," but that the colour was poor and the staple extremely short and wasty. On this account they stated that only a nominal valuation could be given, and quoted about $3\frac{3}{4}d.$ per lb. for the cotton in London. On the same day "fine Bengals" was quoted at $4\frac{1}{4}d.$ per lb.

This cotton was a typical Indian variety, being short in staple and harsh to the touch. It contained a quantity of very short fibre, and would therefore prove wasteful in the processes of manufacture. The characters of the cotton, especially with regard to length and uniformity of staple, could no doubt be improved by more careful cultivation and picking, and the product would then be of greater commercial value.

2. Another sample of so-called "Buri Kapas" from the Singhbhum district was forwarded at a later date by the Director of Agriculture, Bengal, but was found to possess a different character from that of the preceding sample.

It consisted of clean unginned cotton, which was free from leafy matter, fairly soft, of good lustre, and of even pale cream colour, and was entirely free from stains. On ginning, it yielded 32 per cent. of lint. The seeds were of medium size and closely invested with a long grey or greenish-brown down. About

50 per cent. of the seeds examined were withered and would be useless for sowing. A large number of Coleopterous insects (not identified) were found in the sample; they were much smaller than the Mexican boll-weevil, but were somewhat similar in form. Three mutilated specimens of insects, which bore a strong resemblance to the species *Dysdercus* (the cotton stainers) were also found in the cotton. The fibres were from 1·0 to 1·4 inches long and 0·0005 to 0·0010 inch in diameter. The ginned material was valued at about 6*d.* per lb. (with "middling" American at 5·98*d.* and "fine machine-ginned Broach" at $5\frac{9}{16}$*d.* per lb.).

The cotton was of American type, and, notwithstanding the presence of the insect pests, the sample was of very satisfactory quality and free from stains. It is probable that the insects had attacked the cotton at a late stage in its growth, and had thus but little opportunity of damaging the material. The use of some insecticide on the cotton plants would appear desirable.

3. A third sample from the Singhbhum district was forwarded through the Director of Agriculture, Bengal, by the Officiating Reporter on Economic Products to the Government of India, and was labelled "Lambua cotton."

It consisted of very clean ginned cotton, which was fairly soft, of medium lustre and an even deep cream colour, and was free from stains.

The strength was uneven, some portions being rather weak. The fibre was from 0·9 to 1·2 inches long and 0·0005 to 0·0011 inch in diameter.

The material was probably worth $5\frac{1}{2}$*d.* to 6*d.* per lb. (with "fine machine-ginned Broach" at $5\frac{1}{2}$*d.* per lb.), and would be readily saleable.

4. A small sample of tree cotton grown at Sambalpur was forwarded by the Director of Agriculture, Bengal, in January 1908.

This cotton was harsh and woolly, fairly lustrous, of even deep cream colour, free from stains, and of normal strength. The sample was too small to allow the yield on ginning to be accurately determined; the portion examined furnished only 27 per cent. of lint. The fibres were from 1·1 to 1·4 inches long, and had an average diameter of 0·00086 inch.

The seeds were of the "kidney" variety, occurring in clusters of six to nine; about 50 per cent. were withered and consequently useless for sowing.

The cotton was of similar character to Peruvian varieties. It was of very good quality, and would probably find a ready market at about 9*d.* per lb. (with "good fair" moderately rough Peruvian at 9¾*d.* per lb.).

COTTON FROM MADRAS.

Three samples of "Caravonica" cotton were forwarded by the Director of Agriculture, Madras.

"Caravonica cotton No. 1" consisted of clean unginned cotton, which was fairly soft, lustrous, and of even cream colour; a small quantity of stained fibre was present. The yield on ginning was 37·5 per cent. The seeds were large, smooth, and dark brown with light brown tufts at the pointed ends. About 36 per cent. were withered and would be useless for sowing. There were no signs of the attack of insect pests. The fibres were from 1·3 to 1·8 inches long and 0·0005 to 0·0010 inch in diameter. The product was valued at about 13*d.* per lb. (ginned), with "middling" American at 7·18*d.* and "good" Abassi at 14⅞*d.* per lb.

"Caravonica cotton No. 2" was unginned. The cotton was soft, very lustrous, of even cream colour, and free from stains. On ginning, a yield of 29·25 per cent. of lint was obtained. The seeds were of the "kidney" variety, generally occurring in groups of 6 to 8; they were healthy and showed no signs of the attack of insect pests. The fibres were from 1·3 to 1·7 inches long and 0·0006 to 0·0011 inch in diameter. The cotton was valued at about 14*d.* per lb. (ginned), with "middling" American at 7·18*d.* and "good" Abassi at 14⅞*d.* per lb.

The third sample, "Caravonica kidney cotton," consisted of unginned cotton, which was soft, lustrous, and of even cream colour; a small quantity of stained fibre was present. The yield on ginning was 29 per cent. The seed was of the "kidney" variety, and showed no signs of the attack of insect pests. The fibres were from 1·3 to 1·6 inches long and 0·0005 to 0·0011 inch in diameter. The product was valued at about 12*d.* per lb.

(ginned), with "middling" American at 7·18*d.* and "good" Abassi at 14⅞*d.* per lb.

These cottons were similar to fine qualities of improved American Upland varieties, and almost approached a fair grade of Egyptian "Abassi." They were all of excellent quality, and would be readily saleable in the Liverpool market.

The first and third samples contained a small quantity oi stained cotton, the removal of which would enhance the value of the product. The cotton should therefore be carefully sorted before ginning and any stained portions removed.

COTTON FROM BOMBAY.

A sample of native long-stapled cotton, grown at Deesa, Bombay, was examined. It consisted of clean unginned cotton, which was rather rough, fairly lustrous, and of even pale cream colour. On ginning, it yielded only 23·5 per cent. of lint. The seeds were very small, smooth and dark brown in colour, with light-brown tufts at the pointed ends. A small proportion were withered. The fibres were from 1·1 to 1·5 inches long and 0·0004 to 0·0010 inch in diameter. The cotton was of good quality, and would have similar commercial applications to a long-stapled American Upland variety.

Seven samples of cotton were forwarded by the Economic Botanist, Bombay, and are described below.

1. This sample was grown at the Ganeshkhind Botanic Garden, Poona, and was labelled "Caravonica, No. II."

It consisted of ginned cotton, and contained a large quantity of leaf fragments and broken seeds. The material was fairly soft, of poor lustre, very uneven in colour, much stained, and of irregular strength. The fibres were from 0·9 to 1·5 inches long and 0·0005 to 0·0010 inch in diameter. The cotton was of poor quality, and was valued at about 3*d.* per lb. (with "middling" American at 7·16*d.* per lb.), and would not be readily saleable.

2. This sample of long-stapled cotton, known as "Buri" cotton, was grown in the Ganeshkhind Botanic Garden. It consisted of fairly clean ginned cotton, which was soft, fairly lustrous, and cream to white in colour with a quantity of brown stains. The fibres were from 0·8 to 1·2 inches long and 0·0005 to

0·0011 inch in diameter. The material was valued at about 4*d.* per lb. (with "middling" American at 7·16*d.* per lb., and "fine machine-ginned Broach" at 6¼*d.* per lb.). It was of low quality, and would not be in any demand.

3. This sample, described as "Bourbon" cotton, consisted of ginned cotton, and contained a quantity of dust, leaf fragments and broken seeds. It was fairly soft, of rather poor lustre, cream to white in colour with a large quantity of brown and yellow stains, and of poor strength. The fibres were from 0·9 to 1·3 inches long and 0·0005 to 0·0011 inch in diameter. This cotton was of poor quality; it was valued at about 3½*d.* per lb. (with "fine machine-ginned Broach" at 6¼*d.* per lb.), and would not be readily saleable.

4. This sample, labelled "D × G" cotton, consisted of fairly clean ginned cotton containing some broken seeds. It was rather harsh, lustrous, of a deep cream colour with some yellow and brown stains, and of uneven strength. The fibres were from 0·8 to 1·2 inches long and 0·0004 to 0·0011 inch in diameter. The cotton was valued at about 4*d.* per lb. (with "middling" American at 7·16*d.* and "fine machine-ginned Broach" at 6¼*d.* per lb.), and was of slightly better appearance than the preceding samples.

5. This sample, labelled "Cotton Bilaspur, No. 185c, *G. neglectum*," consisted of ginned cotton containing a quantity of dust, leaf fragments and broken seeds. It was harsh, fairly lustrous, pale cream to white in colour with a quantity of brown and yellow stains. The fibres were from 0·8 to 1·1 inches long and 0·0005 to 0·0011 inch in diameter. This cotton was of very poor quality; it was valued at about 3¼*d.* per lb., but would not be in any demand.

6. This sample, labelled "Dharwar American, *Gossypium hirsutum*," consisted of ginned cotton containing a quantity of leaf fragments and broken seeds. It was rather harsh, lustrous, and cream to white in colour with some yellow and brown stains. The fibres were from 0·9 to 1·2 inches long and 0·0005 to 0·0011 inch in diameter. The cotton was of poor quality, and was valued at about 4*d.* per lb. (with "middling" American at 7·16*d.* per lb.).

7. This sample, labelled "Soft Peruvian cotton, *Gossypium sp.*

No. 1," consisted of ginned cotton containing a quantity of leaf fragments and crushed seed. It was soft, fairly lustrous, rather weak, deep cream in colour and slightly stained, but not as much so as the preceding samples. The fibres were of irregular length, varying from 1·0 to 1·6 inches, and of diameter from 0·0005 to 0·0010 inch. The cotton was of fairly good appearance, but not fully mature, and would prove very wasteful in the processes of manufacture. It was valued at about 4½*d.* per lb. (with "good fair" smooth Peruvian at 7·84*d.* per lb.).

The chief defects noted in these cottons were the presence of stains, apparently caused by insect pests, and of broken and crushed seed due to imperfect ginning. If means were adopted for combating the attacks of insect pests, and greater care exercised in ginning, the cotton would be greatly improved and would be more likely to find a market in this country.

COTTON FROM BURMA.

Five samples of Upland cotton grown in the Myingyan district, Burma, were forwarded through the Director of Agriculture, Burma, by the Officiating Reporter on Economic Products to the Government of India.

1. This sample, labelled "Early Carolina Prolific," consisted of fairly clean unginned cotton. The lint was very soft, of good lustre, and pale cream in colour with a large quantity of brown and yellow stains, and was of uneven strength. On ginning, the cotton yielded 31·2 per cent. of lint. The seeds were of medium size and generally covered with a grey or greenish-brown down. Twenty-five per cent. of the seeds examined had been attacked by insect pests. The fibre was from 1·0 to 1·3 inches long and 0·0005 to 0·0010 inch in diameter. The ginned cotton was regarded as nominally worth about 6*d.* to 6½*d.* per lb. (with "middling" American at 6·63*d.* per lb.). This sample was of very good lustre and colour, but much depreciated in value by the stained portions.

2. This sample, labelled "King's" variety, consisted of clean unginned cotton, which was very soft, lustrous, of a pale cream colour with a quantity of yellow and brown stains, and of irregular strength. On ginning, it furnished 36·5 per cent. of lint. The seeds were generally large and thickly invested with

a green or brownish-grey down. Thirty-six per cent. of the seeds examined were withered, having been attacked by an insect pest. The fibres were from 0·9 to 1·3 inches long and 0·0005 to 0·0011 inch in diameter. The ginned cotton was considered to be nominally worth about *6d.* to *6½d.* per lb. (with "middling" American at *6·63d.* per lb.). This sample was a little more even in colour than the preceding, but was not equal to a standard sample of cotton grown from selected American seed.

3. This sample, labelled "Excelsior," consisted of clean unginned cotton, which was very soft, lustrous, of a rather deep cream colour with a quantity of brown and yellow stains, and of uneven strength. On ginning, it yielded 32·7 per cent. of lint. The seeds were of medium size and generally covered with a short green or greyish-brown down, but some smooth dark-brown seeds were also present. Forty-five per cent. of the seeds examined were withered and showed signs of the attack of insect pests. The fibres were from 1·0 to 1·3 inches long and 0·0005 to 0·0011 inch in diameter. The ginned cotton was stated to be nominally worth about *6d.* to *6½d.* per lb. (with "middling" American at *6·63d.* per lb.). This cotton was similar to the preceding samples, and was of very promising quality.

4. This sample, labelled "Texas Burr," consisted of clean unginned cotton, which was very soft, lustrous, of a light cream colour with a large quantity of brown and yellow stains, and of irregular strength. On ginning, it yielded 33 per cent. of lint. The seeds were of medium size and covered with a brownish-grey or green down. Forty-eight per cent. of the seeds examined had been attacked by an insect pest. The fibres were from 0·9 to 1·3 inches long and 0·0005 to 0·0013 inch in diameter. The ginned material was regarded as nominally worth about *6d.* to *6½d.* per lb. (with "middling" American at *6·63d.* per lb.). This sample contained many boll-lobes which were quite immature, and which had been punctured by insect pests. If such unripe portions were excluded, the value of the cotton would be greatly enhanced.

5. This sample, labelled "Russell's Big Boll," consisted of unginned cotton, which was very soft and lustrous, of a deep cream colour with some yellow stains, and of uneven strength. On ginning, it yielded 31·3 per cent. of lint. The seeds were of

medium size and covered with a brownish-green or light-grey down. Thirty per cent. of the seeds examined were withered and hollow, and showed signs of the attack of insect pests. The fibres were from 0·9 to 1·2 inches long and 0·0005 to 0·0011 inch in diameter. The ginned cotton was regarded as nominally worth about *6d.* to *6½d.* per lb. (with "middling" American at 6·63*d.* per lb.).

These samples were in no case equal to similar cotton grown in the United States, which is worth about *2d.* per lb. more than "middling" American. The present samples were all stained and partly immature, and consequently the colour was decidedly inferior to that of a standard American sample. The unripe fibres would cause the cotton to be wasteful in the processes of manufacture, and the resulting yarn would be weak.

Notwithstanding these defects the samples were of very promising quality, and by greater care in cultivation and the adoption of remedial measures against insect pests, a much improved cotton could probably be produced.

BUAZÉ FIBRE FROM NYASALAND.

ATTENTION was first drawn to the fibre of *Securidaca longepedunculata*, known as Buazé fibre, by Dr. Livingstone, in 1857. A sample was submitted to commercial experts, who reported that the fibre resembled flax worth £50 to £60 per ton, but that no positive statement as to its value could be made until sufficient material had been received to enable spinning trials to be carried out. (Compare *Kew Bulletin*, 1889, 222–225.)

The possibilities of the commercial utilisation of Buazé fibre, however, received no further consideration until, at the end of the year 1905, a small bale of the material and a further small sample were received at the Imperial Institute from Nyasaland.

Description of Samples.

The small sample of fibre was labelled as follows:—"British Central Africa. Buazé fibre, *Securidaca longepedunculata.* As collected and prepared by natives, Zomba, April to June, 1905."

The fibre was from 1 foot 5 inches to 2 feet 2 inches in length, and of a yellowish colour. It was badly cleaned and prepared, many of the fibres being still gummed together. When clean, the fibre was strong, fine and flax-like.

The consignment was, on the whole, not so well prepared as the small sample, and was of a very mixed character, much of the material consisting merely of strips of bark. A further description is given under the heading "Technical Examination."

Chemical Examination.

The following are the results of the chemical examination of the fibre. The small sample was insufficient for complete examination, and therefore a quantity of similar fibre was selected from the bale for the purpose :—

	Small Sample. *Per cent.*	Sample taken from bale. *Per cent.*
Moisture	6·7	6·5
Ash	1·8	1·8
α-Hydrolysis (loss)	—	18·8
β-Hydrolysis (loss)	—	23·5
Acid purification (loss)	—	11·5
Nitration (gain)	42·0	43·3
Cellulose	69·2	74·5

Length of ultimate fibre . . {0·6 to 1·5 inch; mean 0·9 inch.

The fibre, although badly cleaned, as is shown by the large loss on acid purification, contained a fair percentage of cellulose, and did not suffer great loss on hydrolysis. It was not lignified.

Technical Examination.

Two kinds of material were present in the large sample submitted for examination.

The first was a coarse fibre obtained from the bark of the thick stems, whilst the second consisted of strips of bark apparently derived from the thinner twigs.

The coarse fibre could be prepared by hackling. It was very

short, but might be utilised for the manufacture of rough bags; its commercial value would, however, be low.

The strips of bark from the thin twigs were subjected to a retting process, and the fibre thereby obtained was found to be of good lustre and strength and of satisfactory colour. On account of the much-branched character of the twigs—a serious defect—the fibres were much reduced in length during this operation.

The fibre obtained from the thin twigs could probably be utilised as a textile material, but further experiments will be necessary as to the best methods of extracting the fibre from the bark. It seems likely that the best results would be obtained by scraping the thin bark on the spot before the plant juices have dried on the fibre; the scraped fibre could be degummed later.

It was found from laboratory experiments that the bark from the twigs yielded about 37 per cent. of clean fibre.

A representative specimen of the fibre from the bale was submitted to a commercial expert, who stated that in the condition in which it was received it was of very little practical value. He also pointed out that the irregularity in the length of the fibre was a bad feature of the material, which would result in much waste in the process of retting.

A sample of the prepared fibre, which had been retted at the Imperial Institute, was also forwarded to the expert, who reported that if this could be produced sufficiently cheaply it might be used in the place of flax tow, which is at present quoted at about £30 per ton.

The expert carried out a series of experiments on the retting of the fibre, and stated that the gums present were very difficult to soften and remove. The ordinary treatment was found to be useless, and the only method of removing the gums was apparently to scrape them off by hand after the steeping process. This would be an impossible course of procedure unless labour is very plentiful and cheap.

There is no doubt that the Buazé plant contains a large quantity of excellent fibre, which would be of a useful character if suitable means of getting rid of the gums could be found.

Further experiments are being made in retting the fibre. It

was suggested that attempts might be made to extract the fibre on the spot from the fresh plants by scraping the bark immediately after its collection, and that results of such experiments should be communicated to the Imperial Institute, together with specimens of the products obtained.

RUBBER OF *FICUS ELASTICA* FROM INDIA.

SEVERAL samples of *Ficus elastica* rubber from India have been examined recently at the Imperial Institute, and the results obtained are recorded in the following account.

Ficus elastica Rubber from Assam.

Two specimens of this rubber from the Kulsi Plantation in the Kamrup Division of Assam were submitted for analysis and valuation.

(1) "Tree Rubber from *Ficus elastica*."

The specimen consisted of an irregular cake of rubber formed by the aggregation of thin strips. The rubber was reddish-brown, clean, free from stickiness, and exhibited good elasticity and tenacity.

A chemical examination furnished the following figures:—

	Per cent.
Moisture	0·7
Caoutchouc	78·0
Resin	19·0
Proteids	0·9
Insoluble matter	1·4
Ash	0·49

The rubber was valued at 4*s.* 3*d.* to 4*s.* 6*d.* per lb. in London, the current price of fine hard Para from South America being 5*s.* 2*d.* per lb.

The percentage of resin in this rubber is higher than is desirable, but otherwise it is of satisfactory quality and would be readily saleable.

(2) "Mat Rubber from *Ficus elastica*."

This was a small piece of dark-brown rubber composed of

several thin sheets firmly attached together. The rubber was soft, sticky, and rather weak.

The rubber was found to have the following composition :—

	Per cent.
Moisture	2·1
Caoutchouc	80·0 (including proteids)
Resin	16·0
Insoluble matter	1·9
Ash	1·94

The specimen was valued at 2*s.* to 2*s.* 3*d.* per lb. in London, but would be difficult of sale on account of its soft, sticky character.

The sample was too small for complete chemical examination, and consequently it was not possible to determine the amount of proteids present. The percentage of the latter constituent is included with the "caoutchouc."

This rubber contains a little less resin than the "tree rubber," but on account of its weak, sticky character it is much inferior in value. The stickiness may be due to the plan of placing the mats covered with rubber in the sun to dry. It would be preferable to effect the drying in the shade so as to avoid over-heating the rubber.

Ficus elastica Rubber from Madras.

Two specimens of this rubber obtained at Mukkie in the Kanoth Range, North Malabar, have also been examined.

(1) *Ficus elastica*, scrap rubber.

A cylindrical lump of reddish-brown rubber, made up of aggregated shreds, and weighing 12½ oz. The rubber was clean, free from stickiness, but rather weak.

The rubber had the following composition :—

	Per cent.
Moisture	0·9
Caoutchouc	67·3
Resin	28·1
Proteids	0·9
Insoluble matter	2·8
Ash	0·47

The sample was valued at 2*s.* 11*d.* per lb. in London, with fine hard Para quoted at 3*s.* 5½*d.* per lb.

This rubber contains an excessive amount of resin, which adversely affects its physical properties.

(2) *Ficus elastica*, "biscuit" rubber.

A large circular biscuit of black rubber weighing 8 oz. The rubber was clean, free from stickiness, but deficient in elasticity and tenacity.

A chemical examination gave the following results:—

	Per cent.
Moisture	4·0
Caoutchouc	71·2
Resin	22·7
Proteids	1·0
Insoluble matter	1·1
Ash	1·68

The specimen was valued at 2*s.* 5*d.* per lb. in London, with fine hard Para from South America quoted at 3*s.* 5½*d.* per lb.

This sample contains a little less resin than the preceding specimen, but on account of its dark colour it would not realise such a good price.

RUBBERS FROM THE GOLA FOREST, SIERRA LEONE.

A NUMBER of samples of rubber obtained by Captain H. H. Bond during a patrol of the portion of the Gola Forest adjacent to the Liberian Frontier, were forwarded for examination to the Imperial Institute by the Colonial Office. It is reported that portions of the Gola Forest are very rich in rubber-yielding vines, but no information is available regarding the botanical identity of the plants. The results of the examination of the rubbers will, however, be of interest. With the exception of Sample IV., which contained a large percentage of resin, the rubbers are of very promising quality, and there is no doubt that, if carefully collected and prepared, they would command satisfactory prices in the market.

I. Rubber from Forest near Manina.

The sample was a thick sausage-shaped piece of rubber, weighing 5 oz.; it was dark-coloured externally, but pinkish-white and moist within when freshly cut. The rubber was strong and fairly clean.

The rubber had the following composition:—

	Sample as received. Per cent.	Composition of dry rubber. Per cent.
Moisture	10·3	—
Caoutchouc	66·7	74·4
Resin	11·8	13·1
Proteids	5·4	6·0
Insoluble matter	5·8	6·5
Ash	2·25	2·51

The specimen was valued by brokers at 4*s.* per lb. in London. For comparison with this and the following valuations it may be stated that the current value of fine hard Para from South America was 5*s.* 2*d.* per lb.

This rubber is of very fair quality, although the percentages of resin and proteids are rather high. It exhibited very good physical characters, and there is no doubt that it could be improved by careful collection and preparation.

II. Rubber from Bandi country.

A thick sausage-shaped piece of rubber, weighing about 12 oz.; it was dark-coloured externally, but whitish and very moist within when freshly cut. The rubber was sticky, and contained much impurity in the form of fragments of bark.

A chemical examination furnished the following results:—

	Sample as received. Per cent.	Composition of dry rubber. Per cent.
Moisture	20·1	—
Caoutchouc	67·4	84·3
Resin	4·5	5·6
Proteids	0·9	1·1
Insoluble matter	7·1	9·0
Ash	0·89	1·11

The sample was valued at 2*s.* to 2*s.* 3*d.* per lb. in London.

This rubber is satisfactory so far as chemical composition is concerned, the percentages of resin and proteids being low. It had, however, been badly prepared, and on account of its stickiness would only fetch a low price. Careful preparation would remedy this defect, and would also reduce the rather large amount of insoluble impurity present in this sample.

III. Rubber from Gola Forest near Bobabu.

The sample consisted of three pieces of rubber, of irregular shape, and formed by the aggregation of thick strips. The rubber was light-coloured, strong and clean.

The rubber had the following composition:—

	Sample as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	11·3	—
Caoutchouc	77·6	87·4
Resin	5·3	6·0
Proteids	1·4	1·6
Insoluble matter	4·4	5·0
Ash	1·57	1·77

The specimen was valued at 4*s.* per lb. in London.

This rubber is of very good quality, and would meet with a ready sale at satisfactory prices.

IV. Rubber from Gola Forest on left bank of Morro River.

A thick lump of rubber, weighing about 6 oz., dark-coloured on the surface, but lighter within and moist; it possessed a disagreeable odour. The rubber was weak and slightly sticky, but contained very little vegetable impurity.

The rubber had the following composition:—

	Sample as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	14·2	—
Caoutchouc	62·0	72·2
Resin	21·3	24·8
Proteids	1·0	1·2
Insoluble matter	1·5	1·8
Ash	0·57	0·66

The sample was valued at 3*s.* per lb. in London.

This rubber is of poor quality on account of the large amount of resin present. This defect may possibly have arisen through admixture with inferior latex, and if so it could be remedied by greater care in collection.

V. Rubber from Tunkia Forest.

Two pieces of rubber of irregular shape, dark-coloured externally, but white within when freshly cut; a fair amount of vegetable impurity was present. The physical properties of the rubber were very satisfactory.

A chemical examination furnished the following results:—

	Sample as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	4·4	—
Caoutchouc	81·5	85·2
Resin	5·0	5·2
Proteids	1·1	1·2
Insoluble matter	8·0	8·4
Ash	1·16	1·21

The sample was valued at 4*s.* per lb. in London.

This rubber is of very good quality, and would be readily saleable. Careful collection would eliminate the greater part of the vegetable impurity present in the sample.

IRON ORE FROM NATAL.

THIS sample of iron ore was forwarded to the Imperial Institute by the Agent-General for Natal with a request that it might be examined and information supplied as to the possibility of developing an export trade in the ore from the Colony. It is understood that the sample is from a surface outcrop at Sweetwaters.

The sample was stated to have been taken from one of the most extensive deposits near the railway, and in order to obtain an average sample, pieces were collected from several places extending over a distance of a mile. The ore from this deposit

is said to be not the best obtainable in the Colony, but according to local analysis contains 55 per cent. of iron and 5 per cent. of manganese.

Description of Sample.

The sample weighed about 1 lb., and consisted of fragments of brownish limonitic ore without visible quartz or other impurity.

Results of Examination.

The following are the results of the chemical examination of the ore :—

		Per cent.	
Ferric oxide	Fe_2O_3	71·31	*Equivalent to* 49·91 *per cent. of metallic iron*
Ferrous oxide	FeO	*nil*	
Manganese oxide	MnO	2·36	*Equivalent to* 1·82 *per cent of metallic manganese*
Silica	SiO_2	6·08	
Phosphoric acid	P_2O_5	0·70	*Equivalent to* 0·30 *per cent. of phosphorus*
Sulphur	S	*nil*	

It will be seen from the above figures that this sample of the ore is not quite of such good quality as was indicated by the local analysis, which gave 55 per cent. of iron and 5 per cent. of manganese, whereas the present specimen contains 50 per cent. of iron and only 1·82 per cent. of manganese.

Commercial Valuation.

The results of the analysis were communicated to iron smelters and also to iron ore brokers, whose reports agreed in valuing the ore at not more than 16*s.* per ton delivered in this country. This rather low price is due to the high percentage of phosphorus present. Ore containing 50 per cent. of iron, but only 0·03 per cent. of phosphorus, would be worth 20*s.* per ton delivered.

The price quoted for the ore does not appear to be sufficient to render the exportation of similar material to this country remunerative, but this is a matter for local consideration.

It is possible that in certain parts of the field ore may be found containing much less phosphorus, and consequently worth a higher price, and it was suggested that inquiries should be made on this point.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

USES, PROPERTIES AND PRODUCTION OF GUMS.

THE term "gum" is used commercially to designate a great variety of natural products, including such diverse materials as the true gums derived from acacia and tragacanth trees, resinous products such as benzoin and copal, drugs such as kino and opium, and miscellaneous substances like camphor, gutta-percha and rubber. The name should, however, be reserved for products such as gum arabic and gum tragacanth, which are miscible in all proportions with water to form highly viscous liquids known technically as "mucilage" (or colloquially, in referring to the common mucilage made from gum arabic and used for adhesive purposes, as "gum").

Gums are used for a great variety of purposes in the arts, and as the trade in gum is of considerable dimensions and of great importance in several British colonies and dependencies, it has been thought that some account of these products might be given in this *Bulletin*, especially as general information on the subject is not readily accessible in English.

The true gums are divisible roughly into three classes—(a) *soluble gums*, typified by those produced in the Anglo-Egyptian Sudan and in Senegal, which dissolve in water, forming transparent solutions; (b) *insoluble gums*, represented by tragacanth gum, which, when placed in water, absorbs the latter and swells into a jelly, and finally on addition of sufficient water breaks down into a very thick transparent solution; (c) *half-insoluble gums*, such as "Persian insoluble gum," which is intermediate in properties. It partially dissolves in water, leaving a swollen jelly, which on the addition of more water also passes into solution.

These three classes of true gums may be readily distinguished from the resins, balsams and drugs to which the term "gum" is often wrongly applied in commerce, by the fact that they are miscible with water in all proportions and are insoluble in liquids such as alcohol, oil of turpentine, benzene, or fatty oils.

USES OF GUMS.

Soluble gums are applied to a great number of purposes in the arts. The finest and least-coloured varieties are employed in the clearing of liqueurs, the "finishing" of silk, and in the preparation of fine water colours. The other high-class grades find application in confectionery and pharmacy, in sizing and the "finishing" of textiles and paper, in calico-printing, and certain dyeing processes. The less costly varieties are used in the manufacture of stationery, matches and inks.

The value of a gum for use in confectionery depends principally upon its freedom from colour, odour and taste, and its "strength" as measured by its viscosity. For pharmaceutical use a fairly high viscosity, considerable adhesive power and freedom from colour are the principal requirements; for sizing purposes a high viscosity is the chief requisite, though freedom from colour is still an important matter; for the preparation of mucilage to be used in the manufacture of stationery, adhesive power is the principal factor taken into account, though for certain special work the absence of a dark colour is advantageous.

The commercial value of a gum, therefore, depends largely on the purposes for which it is suited, the highest price being obtained for gums suitable for sizing silk and for the use of confectioners and pharmacists, and the lowest for those which can only be employed for sizing coarse materials and for the preparation of ink, etc.

As regards the insoluble gums, tragacanth is in frequent use as one of the thickening agents necessary in preparing the mixtures of colours used in calico-printing. In this industry coloured pastes of suitable consistence are printed on the fabrics, and it is most important that the colours should not run, but should produce patterns with sharply defined edges. Great skill and experience are required in preparing such pastes. It is stated that in giving consistence to a liquid, with equal parts of water, 10 parts of gum tragacanth are equivalent to 20 parts of starch, or 22 parts of wheat flour, or 130 to 140 parts of "calcined" starch. It is important that the gum used should not affect the brightness of delicate colours, nor weaken the

mordants by its acidity or in other ways; it is also desirable that the thickening agent should not penetrate too far into the fabric. In printing dark colours, the smaller the quantity of thickening agent that will give the necessary consistency, the less the colour is lightened by dilution.

Tragacanth is also used in pharmacy for keeping heavy powders in suspension in liquid preparations.

CHEMISTRY OF GUMS.

The present position of our knowledge of the chemistry of gums formed the subject of a report prepared for the York meeting of the British Association for the Advancement of Science by Mr. H. H. Robinson, of the Scientific and Technical Department of the Imperial Institute, and from this report the following summary is made.

The gums are uncrystallisable substances composed of carbon, hydrogen and oxygen. As found in nature they contain more or less ash constituents, and sometimes a little nitrogen. The nitrogen, if present, is small in amount, and is not regarded as an essential component, and this differentiates them from gelatin, glues and proteids, which resemble the gums in their physical properties, but contain a considerable proportion of nitrogen.

Different views have been held as to the processes by which gum is formed in the plant. One view considers the production of gum as part of the normal processes in plants; in the case of tree gums they are generally regarded as an excretion resulting from the breaking down of cell tissue. In certain cases the formation has been attributed to the action of a fungus, which attacks the tree and generates an enzyme (unorganised ferment) that penetrates the tissues and transforms the cell walls, etc., into gum. A third view attributes it to bacterial action, and it is claimed that specific bacteria have been found capable of producing different kinds of gum. The employment of a system of inoculating the trees to cause the production of gum has been suggested, but the evidence in support of it is as yet very slight.

The views held regarding the chemistry of the gums have passed through various stages. The work done in the early part

of the nineteenth century resulted in the description of the properties of a few gum substances believed to be individual chemical compounds, to which the names *bassorin*, *cerasin* and *arabin* were given. *Bassorin* was the substance constituting "gum Bassora," a gum having properties somewhat similar to those of tragacanth, but not so highly valued. It derived its name from the Turkish port now called Basra, at the head of the Persian Gulf, from which there is a considerable export of gum. *Cerasin* was the gum substance obtained from the fruit of the plum known as "Mirabel," and also from the stem of the wild cherry tree (*Prunus avium*). The gum of the sweet cherry tree is of a different nature. *Arabin* was the gum substance of gum arabic and of Senegal gum, and *para-arabin* was the name proposed for an insoluble form of the same substance. After these names had been assigned, chemists, dominated by the idea that the number of organic compounds was only small, on investigating a gum, identified its constituents with one or more of these substances. As these identifications rest on a few simple properties, but little weight attaches to them. In fact, it now appears that the number of gum compounds is very considerable; consequently, in reading the literature of the last century, statements that the author had found arabin, or cerasin, or bassorin, etc., do not throw any certain light on the nature of the substance found, as it cannot be safely inferred that it is the same substance as the arabin, or cerasin, or bassorin, etc., found in another natural product by another author.

In the middle of the century it was discovered that gum arabic is composed of an acid to which the name "arabinic acid" or "arabic acid" was given; in the natural gum this acid is united to bases (calcium, magnesium, etc.) forming salts. Until the end of the century the gums were believed to be carbohydrates—that is, substances like sugar, starch and cellulose, which are composed of carbon united to hydrogen and oxygen, present in the same proportions as in water, and the formulae $C_{12}H_{22}O_{11}$ or $(C_6H_{10}O_5)n$ were assigned to them. Towards the end of the century, however, it was shown that the gum substances are not carbohydrates, but are complex acids built up of a nucleus acid with which are combined several of the less common sugars, such as galactose, arabinose, and xylose. The natural gums are

mixtures of the potassium, calcium and magnesium salts of one or more of these complex acids. Among the nucleus acids are arabic acid in gum arabic, geddic acid in "Gedda gum," and bassoric acid in gum tragacanth. The name "arabic acid" is here used for the nucleus acid and not for the complex natural acid, for which the term "arabinic acid" is more suitable.

The proportions of the sugars united to the nucleus acid to form the natural complex gum acid, and the proportions of the complex acids in the mixture that constitutes the natural gum, appear to vary in different seasons, since investigations have shown that the properties of the gum of a given plant are not always the same.

Analysis and Valuation of Gums.

Closely allied to the subject of the chemistry of gums are those of their analysis and valuation for industrial purposes. The analysis of a gum may be undertaken with one of two objects in view—(1) the detection of sophistication, or (2) the determination of its value in comparison with standard classes of commercial gum. At one time, when gum of good quality was scarce and dear, the first object was frequently of some importance, but at present gum of fine quality is so cheap that adulteration is scarcely remunerative, and the object of analysis is usually to ascertain how a sample compares with standard materials. During the last few years a considerable number of analyses of gums have been made at the Imperial Institute, and the results of the most important of these are given in the course of this article.

One of the most important factors in determining the quality of a gum is the viscosity (or roughly "thickness") of the solution it forms with water, and as no standard method is yet in use by analysts for observing this constant in the case of gums, the results recorded by different investigators are not comparable, and this difficulty renders it necessary to refer in some detail to this matter here.

The simplest method of determining the viscosity of a solution is to allow a quantity to flow out of a tube, provided with a capillary orifice, under its own weight and to note the "time of flow." In this method the pressure under which the liquid

flows varies continuously, and there are other disturbing factors which render the results so obtained of little value, though the method is still in use as affording a rough comparison of the viscosity of a solution of one gum with that of another.

A second method, which is an improvement on the foregoing, is to note the time taken by a definite volume of the liquid to flow out of a tube, provided with a capillary orifice, under a constant pressure due to a column of the same liquid maintained of the same length throughout the operation by a regulated inflow from an external supply.

Lastly, recourse may be had to the use of a viscosimeter consisting of a capillary tube, enlarged at one part of its length into a cylindrical bulb, along a definite length of which, including the bulb, a measured volume of the liquid is caused to flow by its own pressure and the time in seconds required for this is noted. This last method is that used in the Scientific and Technical Department of the Imperial Institute, the viscosimeter briefly described above being merely a modified form of that described by Ostwald (*Physico-chemical Measurements*, 1st edition, p. 163). Dr. Beam, of the Gordon College at Khartoum, has suggested recently the use of Doolittle's viscosimeter for the determination of the viscosities of gum solutions. The working of this instrument is based on the fact that the resistance offered by a liquid to the rotation in it of a metallic disc is dependent on the viscosity of the liquid. This method of measuring viscosity has been used largely in the United States for determining this constant in the case of lubricating oils, but has been little applied elsewhere, and as all the methods in general use for gums depend on the flow of liquids out of or through glass tubes, it seems desirable to develop a more accurate method on these lines rather than to apply an instrument depending on a different principle. It is, perhaps, also worth mentioning in this connection that the determination of the viscosities of solutions of salts in water has been the subject of much investigation in recent years, and in most of this work viscosimeters of the capillary tube type have been employed on account of their greater accuracy; and although in the analysis of a gum for commercial purposes the refinements which are necessary in the pursuit of a purely

scientific investigation need not be introduced, the fact that more accurate results are obtainable by the use of a capillary tube viscosimeter affords an additional reason for adhering to such a method.

As the samples of gum dealt with in this article have been examined at different times during the last ten years, the methods in use for determining the viscosity have varied, and in order that the results now given may be comparable throughout, the viscosities have been redetermined and reduced to a common standard. Most of these results bear to each other much the same relation as was shown by the former determinations, but in a few cases the viscosities have shown considerable changes. This is particularly the case with the sample of "Sudan Hashab gum of 1904" and "Gomme du bas du fleuve" from Senegal (see page 38). The viscosities of 10 per cent. solutions of these gums when determined in 1905 were in the *ratio* 1 : 1·6, but on redetermination this year the ratio obtained is 1·4 : 1. Similar changes have been noted in the case of some of the Northern Nigeria gums subsequently referred to, but in no other case is the change so marked as in this instance.

It will be evident from what has been said above that the viscosity of a gum solution is an important factor in arriving at an indication of the value of the gum, and it is desirable that a uniform method of determining this constant should be adopted, since this seems to afford the readiest means for a systematic investigation of the quality and nature of gum produced under different conditions, matters which it is particularly desirable should be studied with a view to the improvement of gum production in such countries as the Anglo-Egyptian Sudan and Northern Nigeria.

PRODUCTION OF GUMS.

THE SUDAN.

The gum produced in the Sudan has been an article of commerce since the first century of the Christian era, when it was shipped from Egypt to Arabian ports and thence sent to Europe, hence the designation "gum arabic," still frequently applied to gums of this type. In the Middle Ages trade in gum was carried on *via* Turkish ports, hence the name "Turkey

gum" still in use, though the trade from Turkish ports has long since ceased. At present the gum is generally known as "Sudan" or "Kordofan" gum.

In the Sudan the best gum is collected from the grey-barked acacia tree, *Acacia Senegal*, known locally as "hashab." Inferior varieties are obtained from the "red" and "white" barked acacias, both of which are varieties of *Acacia Seyal* and are known locally as "talh" or "talha." A certain amount of gum is collected in the Blue Nile district, and there is a fair gum trade at Gedarif, which lies between the Blue Nile and Abyssinia; but the quality of the "hashab" gum produced there is hardly equal to that of the province of Kordofan, which is the principal seat of the gum-collecting industry. Kordofan lies to the west of the White Nile, some 200 miles south-west of Khartoum. In this province the gum is transported either direct to Khartoum by camels or to Goz Abu Guma and El Dueim, towns on the White Nile, and is there put into boats.

The greater part of the gum was formerly dried and cleaned at Omdurman, which lies on the Nile opposite Khartoum; but at present only about 8 per cent. is treated there, and the rest is sent direct to Cairo and Suez or Port Said, where it is exported to Europe, etc. At least one-half goes to Suez. The gum loses about 15 per cent. by evaporation between the garden where it is gathered and the port of export. There is also an export of gum from Suakin, and it is probable that with the completion of the Berber-Port Sudan railway, a much larger proportion of the gum exports will pass *via* this route to the Red Sea and the Mediterranean.

In Kordofan the gum is obtained both from gardens of acacia trees, which are private property, and from wild or unowned trees; the first kind is known as "hashab geneina" (*i. e.* garden hashab), and the second, which is of less value, is known as "hashab wady." The latter exudes naturally from the trees, and is slightly darker in colour; it is usually in pear-shaped pieces of variable size proportionate to the length of time between successive collections. A dirty gum which is sometimes found exuding is known as "kadab," and is rejected.

The conditions favourable to the production of gum are a ferruginous sandy soil, with a good natural drainage, and

probably a moderately heavy rainfall during the rainy season is beneficial, and dry heat during the collecting season. Excessive moisture in soil, otherwise suitable, appears to prevent the production of gum.

In the "geneinas" gum is obtained by artificially incising the trees. Soon after the end of the rains, bark is removed in strips from the principal branches of all trees in the garden, of 3 years old and upwards; the strips should be 1 to 3 inches wide, according to the size of the branch, and 2 to 3 feet in length. They are removed by cutting the bark with an axe and then tearing off by hand. The incision should not penetrate into the wood, and a thin layer of the liber or inner bark should be left covering the wood. About 60 days after barking, the first collection of gum is made, and after that the garden is completely picked over every fourth day until the rains recommence and new leaves appear on the trees; at this stage the exudation ceases. In Kordofan the rainy season ceases at the end of September, and recommences in the middle of June. Young hashab trees, 8 to 10 feet high and 6 to 8 inches in girth, will produce gum, and the limits of age may be taken as 3 to 15 or 20 years; probably trees of 8 to 12 years are the most productive.

"Talh" or "talha" gum is chiefly collected in the forests of the Blue Nile. There are two varieties of the talha acacia tree, *Acacia Seyal;* the bark of one is covered with a red powder and that of the other with a white powder, and they are consequently known as "red" and "white" talha respectively. Both varieties produce gum, but the red talha is more abundant than the white, and consequently most of the talh gum is derived from that variety. The talh trees are said not to be barked or wounded by the collectors, who gather the gum they find exuding.

The gum is cleaned from pieces of bark and other débris at Omdurman or Khartoum, and a small proportion of it is picked, dried, and bleached by exposure to the sun on the banks of the Nile and exported as "picked gum," but the bulk of the product is exported in the mixed condition and is sorted in European centres, one of the most important of these being Trieste.

In 1904 a number of typical samples of Sudan gums were

submitted to the Imperial Institute by the Sudan Government for examination and for comparison with Senegal gum.

The samples supplied were described as follows:—

"No. 1.—Gum of 1904, Hashab, from Kordofan and Gedarif, gathered between November and June. Ninety per cent. is from Kordofan.

"No. 2.—Gum of 1903, Hashab, specially selected and dried.

"No. 3.—Gum of 1903, Gezira, from Gezira and Eastern Sudan, gathered in the dry season.

"No. 4.—Gum of 1903, Talh from Southern Gezira, gathered in the dry season."

Chemical Examination.

The results obtained in the chemical examination of these gums in the Scientific and Technical Department of the Imperial Institute are shown in the following table, which also gives for convenience of comparison the results obtained with commercial samples of Senegal gum of good quality. The results obtained with corresponding qualities of Sudan and Senegal gums are placed as far as possible side by side in the table.

	Sudanese gum. Hashab, 1904.	Senegal gum. "Gomme du bas du fleuve."	Sudanese gum. Specially selected Hashab, 1903.	Senegal gum. "Gomme petite blanche."	Senegal gum. "Gomme grosse blonde."	Sudanese gum. Gezira, 1903.	Sudanese gum. Talh, 1903.
Moisture, per cent. .	13·2	16·10	11·3	16·1	16·0	12·4	12·2
Ash, per cent. . . .	3·1	3·5	3·3	3·0	3·1	2·7	2·6
Dry matter soluble in water, per cent.	86·5	82·0	87·6	80·6	83·0	87·2	85·2
Acidity (Milligrams of potash required per gram of gum)	2·4	1·9	1·2	0·8	1·2	2·0	2·8
Viscosity of 10 per cent. solution . .	31·4*	22·5*	16·3	32·4	28·7	18·7	25·0
Character of Mucilage	Clear, very pale brown. No marked taste or odour.	Opaque, dark brown colour. Slightly bitter.	Clear and almost colourless. No marked taste or odour.	Clear, faintly yellow. No marked taste or odour.	Clear, slightly yellow. No marked taste or odour.	Clear, pale yellow. Slight sour odour.	Clear, pale reddish-brown. Slight burnt taste.

* *See note on page* 35.

These results show that the two sets of Sudanese and Senegal gums examined were quite normal products, the amounts of "ash" and "matter soluble in water" being quite similar to

those usually found in gums of the arabic type. It will be observed, however, that all the Senegal gums contained more moisture than the Sudanese products. The greater brittleness of the tears of Sudanese gums is due to their drying and becoming permeated by innumerable fissures.

The most important differences between the two classes of gums are, however, shown by the colours and the viscosities of their mucilages. Comparing the "Hashab gum of 1904" and the "Gomme du bas du fleuve," which are both natural unpicked gums, it will be seen that the former is much lighter in colour than the latter, a feature which is to the advantage of the Sudanese gum, since absence of a marked colour is a necessity for a number of manufacturing purposes to which gums are applied. On the other hand, the viscosities, that is roughly the "strengths," of the Senegal gums are on the whole higher than those of the Sudanese products. This difference is very noticeable when the specially selected "Hashab of 1903" is compared with the selected "Gomme petite blanche."

In reporting the results of this comparison of Senegal and Sudan gums to the Government of the Sudan, it was pointed out that though it was unsafe to draw general deductions from the comparison of such a small number of samples, yet there appeared to be some ground for the opinion that Senegal gum was for some purposes superior to the Sudanese product, though the latter had the compensating advantages of being cleaner and of lighter colour. A number of suggestions were also made as to the necessity of systematically examining the gum produced from year to year in the Sudan, so that data could be accumulated for the solution of questions of this kind as they arose, and the suggestion was made that it might be desirable to classify Sudan gum into a larger number of grades before export than at present.

The Sudanese gums were submitted for trial to a firm of manufacturing confectioners, who described the

"Hashab gum of 1903" (specially selected and dried) as a white clean gum, yielding a very pale, clean, viscous solution and of good flavour; and the "Hashab gum of 1904" as consisting of fine bold nodules free from dirt and giving a pale, highly viscous solution, of good flavour and odour, and there-

fore of special value to confectioners. The "Gezira gum of 1903" was described as yielding a somewhat darker but still satisfactory solution, fairly viscous, with a sourish smell, but good flavour. The "Talh gum of 1903" was regarded as unsuitable for confectioners' use. Commercial experts valued the four products at 35*s*. to 37*s*., 25*s*. to 26*s*., 23*s*., and 18*s*. per cwt. respectively.

During a visit to Trieste in 1907 the Director of the Imperial Institute obtained an interesting series of samples comprising (1) natural Sudan gums as imported into Trieste, and (2) graded Sudan gums as produced by the Trieste system of picking. These samples have been submitted to a preliminary examination at the Imperial Institute and have given the following results.

Unsorted Gums as imported into Trieste from the Sudan.

No. 50.—*Kordofan Gum.* This is the variety known in the United Kingdom as Kordofan soft gum, and consists of light-coloured pieces which have been bleached and dried in the sun. It closely resembles the "specially selected hashab of 1903" referred to on pages 38 and 39, but is of slightly lower quality, being somewhat more coloured. Viscosity of 10 per cent. solution 22·6.

No. 51.—*Gum arabic, natural, cleaned.* This is Kordofan soft gum, consisting of darker pieces than the previous sample, and has been prepared in the same manner by drying and bleaching in the sun. Viscosity of 10 per cent. solution 20·2.

No. 58.—*Gum arabic "soft."* This is a Kordofan soft gum of slightly poorer quality than No. 50, but containing less dust and dirt than No. 51. Viscosity of 10 per cent. solution 17·6.

No. 54.—*Gum arabic sorts.* This consists of glassy tears of gum, which have not been dried and bleached. Viscosity of 10 per cent. solution 18·4.

No. 56.—*Gum arabic hard.* This is "Kordofan hard gum," consisting of hard glassy tears ranging in colour from almost pale yellow to pale reddish brown. Viscosity of 10 per cent. solution 61.

No. 55.—*Gezira gum.* This is collected in the district of Gezira from *Acacia Senegal*, and possibly other species. It

consists of a mixture of small pieces of gum ranging in colour from nearly colourless to dark reddish brown. Viscosity of 10 per cent. solution 23.

Graded Gums prepared in Trieste from Sudan Gums.

No. 49.—*Grade I.* Consists of a few whole tears with many fragments. Gum colourless or very pale yellow. A few of the fragments are glassy, but most are nearly opaque owing to the presence of innumerable fissures on the surfaces of the tears and fragments. The pieces vary in size from fragments $\frac{1}{4}'' \times \frac{1}{8}'' \times \frac{1}{8}''$ to tears $\frac{3}{4}'' \times \frac{1}{2}'' \times \frac{1}{2}''$. Viscosity of 10 per cent. solution 20·7.

No. 48.—*Grade II.* Consists of a few whole rounded tears with numerous fragments. The gum is pale yellow in colour, but distinctly darker than Grade I. A few of the fragments are glassy, but most of them are opaque due to minute superficial fissures. The pieces vary in size from fragments of about $\frac{1}{8}''$ cube to tears $\frac{3}{4}'' \times \frac{1}{2}'' \times \frac{1}{2}''$. Viscosity of 10 per cent. solution 20·0.

No. 47.—*Grade III.* Contains a fair quantity of whole tears with many fragments. The gum is pale yellow, but of a rather duller tint than either Grades I or II. It contains a larger proportion of glassy fragments than the first two grades, and the other pieces are less opaque. The pieces vary in size from fragments about $\frac{3}{16}'' \times \frac{1}{4}'' \times \frac{1}{8}''$ to tears $1'' \times \frac{3}{4}'' \times \frac{1}{2}''$. Viscosity of 10 per cent. solution 22·4.

No. 53.—*Grade IV.* Includes a few whole tears with many fragments. The gum is pale yellow and not noticeably darker than Grade III, but the fragments contain rather more dirt and vegetable débris. About one-third of the gum is glassy, and the rest more or less opaque. Size much the same as Grade III. Viscosity of 10 per cent. solution 21·0.

No. 46.—*Grade V.* This differs considerably in appearance from the previous four grades. There are few whole tears and practically the whole of the gum is glassy. The size is about the same as Grade II, with some dust. Viscosity of 10 per cent. solution 23·0.

No. 52.—*Grade VI.* Consists wholly of fragments of glassy tears, ranging in colour from pale yellow to a medium orange

brown. The size varies from $\frac{1}{4}'' \times \frac{1}{8}'' \times \frac{1}{8}''$ to $\frac{1}{2}'' \times \frac{3}{8}'' \times \frac{3}{8}''$, with a little dust. Viscosity of 10 per cent. solution 30·0.

No. 57.—*Siftings.* This consists of dust and very small particles of gum, mostly colourless or nearly so, with a few medium or dark brown particles. Viscosity of 10 per cent. solution 19·4.

It is clear from the foregoing results that in grading gum at Trieste particular attention is paid to bringing out the special qualities of Sudan gum, viz. its light colour and its freedom from dirt, and although attention is also paid to securing uniformity in the size of the pieces included in the various grades, this appears to be considered of less importance than the two factors first mentioned.

The viscosities of 10 per cent. solutions of these samples of Sudan gums are also of some interest. It will be seen that the soft gums have generally a lower viscosity than the glassy hard varieties, and that consequently the grades which consist mainly of the glassy hard gum show increased viscosities (compare Beam, Second Report of the Gordon College Research Laboratories, 1906, p. 229), but with the exception of Samples Nos. 52 and 56, the second of which shows an abnormally high viscosity, all these gums show lower viscosities than the two graded Senegal gums examined at the Imperial Institute in 1905. It has already been pointed out that the gum produced by the same tree may vary from season to season, and consequently it is unsafe to draw general conclusions from the examination of such a small number of samples as are here dealt with; but it seems certain that the Sudanese method of drying and bleaching gum by exposure to the sun in heaps, though it produces a clean and almost colourless gum, has the disadvantage of lowering its viscosity and rendering it extremely friable, and that it would be advantageous if the bleaching could be effected by some means which would avoid these defects.

The following tables are sufficient to show the important nature of the Sudan gum trade, and illustrate incidentally the almost complete cessation of trade which occurred during the Sudanese rebellion, and the subsequent recovery culminating in the very large exports of gum recorded for the years 1905 and 1906:—

Exports of Gum from Egypt.

Year.	Kilos.	Value. £ (E.)	Average price per kilo. £ (E.)
1885	1,146,879	97,671	0·08
1890	7,052	469	0·06
1895	149,955	5,856	0·039
1900	1,863,072	93,847	0·050
1905	8,838,483	217,132	0·024
1906	7,689,834	157,330	0·0205

Imports of Gum from Egypt to United Kingdom.

Year.	Cwt.	Value. £	Average price per cwt. £
1902	42,122	90,034	2·1
1903	43,334	82,370	1·9
1904	32,879	47,168	1·4
1905	27,881	41,995	1·5
1906	25,599	35,333	1·3

SENEGAL.

The gum industry of this French colony is of much more recent growth than that which has existed for centuries along the basin of the Nile, but owing to a variety of favouring circumstances, and especially the stoppage of trade in the Sudan which occurred during the Sudanese rebellion, it attained in recent years a position which for a time made it a serious competitor to the gum-collecting industry throughout North-East Africa.

Senegal gum began to appear in European commerce in the seventeenth century, and for a long time the trade in this product was almost entirely confined to France. In the following century, however, it began to be sold in other European countries, and this commerce gradually became more extensive and finally assumed its greatest importance during the rebellion in the Sudan, when competition from Sudanese gum was impossible.

Gum is obtained in Senegal almost entirely from the same plant as in the Sudan, viz. *Acacia Senegal*, but it is probable that the poorer dark-coloured qualities ("Gomme Salabreda") are procured from other species, *e.g. Acacia arabica, Acacia Seyal, Acacia stenocarpa, Acacia Neboueb*, and *Acacia albida*.

The gum exudes naturally through fissures produced by the rapid and unequal desiccation of the bark of the trees by the hot winds experienced immediately after the wet season, but in recent years the gum collectors have endeavoured to obtain larger yields by making longitudinal incisions in the bark; so increasing the apertures through which gum can exude, and perhaps also stimulating the production of gum in the trees. The cupidity of the collectors has also led them to tap immature trees in this way, and it is stated that if these forcing methods are persisted in, much harm will eventually be done to the gum industry in the colony (*Revue des Cultures Coloniales*, Paris, 1901, p. 62).

The gum is collected from December to February ("petite traite") and from April to July ("grande traite"), the best material and the largest quantity being obtained during the second of these periods. It is, as a rule, merely broken off the trees by hand, but knives of various kinds, mounted on shafts, are also employed. The collecting is done by Moors and their dependants; these barter the gum to French traders, who transport it principally to St. Louis and Rufisque, though a small quantity also finds its way to Freetown. From these towns it is exported in skins or jute sacks holding from 80 to 90 kilograms. The gum is subject to a tax of 1 franc 50 centimes per 100 kilograms in the colony, and this is the only tax levied upon it; the export of gum is not encouraged by bounties or other means.

Three qualities of crude Senegal gum are produced. They are described as follows:—

1. *Gomme du bas du fleuve.*

This quality is produced in the district of Podor in Lower Senegal. It is the best of the Senegal gums, and occurs in large rounded or thick vermiform tears. Its colour varies from almost white through a pale sherry tint to brownish yellow. The price of this quality at Bordeaux is about £1 *2s. 2d.* per cwt., less 4 per cent. discount for cash.

2. *Gomme du haut du fleuve.*

This variety is obtained in Fouhlah-land, Guidimaka and Bambouk, all in Upper Senegal. It ranks second in price, and occurs in rounded, vermiform or branched tears, smaller in size

than the first quality, and on the whole darker in colour. The price of this gum at Bordeaux is about £1 0*s.* 2*d.* per cwt., subject to 4 per cent. discount for cash.

3. *Gomme friable, Salabreda,* or *Sadra beida.*

This, the poorest quality of Senegal gum, consists of small grains (showing a tendency to cohere into masses) and small vermiform tears. The latter are usually only slightly coloured, but the grains are brown. The price of this kind at Bordeaux varies from about 17*s.* to £1 0*s.* 2*d.* per cwt.

The relative proportions in which these three qualities were produced in Senegal in 1896 was as follows:—

"Gomme du bas du fleuve" . .	220,239 sacks,
"Gomme du haut du fleuve" . .	44,481 „
"Salabreda"	1,146 „

and it is stated that similar proportions hold in normal years. The average harvest of gum in the colony is stated to be about 3,000,000 kilograms.

Senegal gum is almost entirely exported to France (Bordeaux), as the following table shows:—

Exports of Gum from Senegal.

Year.	To France.		To the United Kingdom.		Total.	
	Quantity in cwts.	Value in £.	Quantity in cwts.	Value in £.	Quantity in cwts.	Value in £.
1897	96,800	188,860	—	—	96,800	188,860
1898	101,040	169,140	2,160	5,806	106,440	178,650
1899	82,980	140,876	—	—	82,980	140,876
1900	49,000	92,682	180	385	49,360	93,440
1901	62,980	116,438	—	—	62,980	116,438
1902	61,740	65,880	—	—	61,740	65,880
1903	42,526	39,173	242	197	43,261	39,871
1904	45,306	43,496	1,313	1,314	46,652	44,835
1905	49,482	50,776	—	—	49,482	50,776

The exports in 1904 and 1905 are for Senegal, Upper Senegal and Niger.

This table also illustrates the effect which the re-opening of the Sudan to trade had on the export of gum from Senegal, and on the price of this material. The average price obtained

for gum in Senegal in 1897 was £1·95 per cwt.; in the two following years it ranged from £1·65 to £1·67, and in 1900 from £1·84 to £1·89. In 1902 it fell to £1·06, and since then no permanent recovery in prices has occurred.

Very little "grading" of gum is done in Senegal, this branch of the industry being almost entirely managed in Bordeaux, and it has been stated that the popularity of Senegal gum is to a large extent due to the care with which it is "sorted" and "picked" (Wiesner, *Rohstoffe des Pflanzenreiches*). The following is an outline of the scheme of "grading" in use.

The gum is first sorted into "whole" and "broken" tears. The "whole" tears are then picked according to colour, when the following grades result.—*Gomme blanche.* This variety is almost colourless. The individual tears are globular, and vary in diameter from 1 to 4 cms. (0·4 to 1·5 inches). The surfaces are covered with a network of minute marks, due to the drying of the gum, but the interior portions are glassy and transparent.—*Gomme petite blanche.* This grade resembles the foregoing, but the tears are smaller, varying from 0·5 to 1·5 cms. (0·2 to 0·6 inch) in diameter.—*Gomme blonde*, resembling *Gomme blanche* in size but rather darker.—*Gomme petite blonde*, resembling *Gomme petite blanche* in size but a little darker in colour.—*Gomme vermicelle*, including vermiform or branched tears, varying in colour from almost white to pale yellow.—*Gomme fabrique*, consisting of tears, which on account of unusual shape or dark colour are unsuitable for the foregoing groups.

The broken gum is sorted by sifting, and gives the following principal grades; these are each fairly uniform in size, but the colour varies from pale yellow to deep brown:—*Gomme gros grabeaux*, *Gomme moyens grabeaux*, *Gomme menus grabeaux*, *Gomme poussiére grabeaux.*

This "grading" applies principally to gum used in France, that re-exported from France to other European countries being usually the first and second qualities of unsorted gum as produced in Senegal. Considerable quantities of the grades "Gomme petite blanche" and "Gomme blonde" are, however, now sent to the United Kingdom.

The following table, showing the imports of gum (which may be taken to be mainly of the Senegal variety) to the United

Kingdom from France, seems to indicate that there is at present a steady demand for Senegal gum in this country.

Imports of Gum Arabic into the United Kingdom from France.

Year.	Quantity in cwts.	Value in £.	Average price per cwt. £
1897	7,000	18,844	2·69
1898	11,140	30,915	2·77
1899	16,990	45,372	2·67
1900	15,815	43,899	2·77
1901	10,754	24,844	2·31
1902	7,023	14,750	2·10
1903	10,774	18,105	1·68
1904	4,378	7,441	1·70
1905	7,360	11,879	1·61
1906	11,770	20,096	1·70

A considerable quantity of Senegal gum is now used in Germany, and the statement has been made that much of it is sold as Kordofan gum in that country. Analyses of a few typical kinds of Senegal gum are quoted on page 38.

NORTHERN NIGERIA.

In this British Protectorate gum and other forest products are collected by the natives and sold to the agents of the Royal Niger Company. The gum so obtained is now a regular article of export to the United Kingdom. A number of specimens of gum from Northern Nigeria have been examined in the Scientific and Technical Department of the Imperial Institute and found to be of excellent quality, though occasionally somewhat dark in colour. In appearance it closely resembles the "Gomme du haut du fleuve" of Senegal, and is usually completely soluble in water and fairly free from dirt. Nothing certain is known as to the botanical origin of this product, but it is probably mainly from *Acacia Senegal.* For results of examination see Table, p. 48. The following tables show the quantities and value of gum exported from the Protectorate in recent years, and the imports of this product to the United Kingdom (*via* Liverpool).

Exports of Gum Arabic from Northern Nigeria.

Year.	Quantity in cwts.	Value in £.	Average price per cwt. £	s.	d.
1900	1,821	1,563	0	17	4
1901	4,041	3,448	0	17	0
1902	4,000	3,410	0	17	0
1905	4,140	3,728	0	18	0
1906	6,080	6,080	1	0	0

Imports of Gum Arabic from Northern Nigeria into the United Kingdom.

Year.	Quantity in cwts.	Value in £.	Average price per cwt. £	s.	d.
1897	166	401	2	8	3
1898	909	1,818	2	0	0
1899	55	110	2	0	0
1900	1,656	3,312	2	0	0
1901	2,416	4,417	1	16	6
1902	3,773	7,502	1	19	9
1903	2,833	3,116	1	2	0
1904	3,130	2,992	0	19	1
1905	4,041	4,849	1	4	0
1906	5,379	5,913	1	1	11

Results of Examination.

	Samples received in 1903.		Samples received in 1904.				Sample received in 1905.	Sample received in 1907.
	Gum from Bassa.	Gum from Borgu.	Gums from Geidam.	Gums from Garfung, Kano.			Gum from Bornu.	Gum of *Acacia caffra* from Kontagora.
				1	2	3		
Moisture, per cent.	15·4	14·5	14·0	17·8	17·8	17·4	15·0	17·7
Ash, per cent.	2·42	2·26	2·9	2·6	2·6	3·2	3·1	2·6
Dry matter soluble in water, per cent.	76·6	82·2	86·0	82·0	79·0	78·0	85·0	81·2
Acidity †	0·0	0·0	1·6	2·0	0·8	0·8	traces	—
Reducing sugars, per cent.	0·0	0·9	—	traces	1·2	traces	*nil*	—
Relative viscosities of 10 per cent. solutions	39 *	22	21·0	14·2	21·2	22·5	21·8	10
Colour of Mucilage (10 per cent.)	pale brown	pale yellow	almost colourless	almost colourless	pale brown	pale brown	pale yellow	almost colourless

* This factor is very uncertain in the case of a semi-insoluble gum.
† Milligrams of potassium hydroxide required to neutralise one gram of gum.

It will be seen that most of these Nigerian gums differ but little from the average quality of unsorted Sudan gum. The

sample from Bassa swelled up in water and contained a good deal of insoluble matter, and would be classed commercially with "half-insoluble" gums. Several of the samples exhibit a rather low viscosity, but the colour is generally good and the samples are as free from dirt as average Sudan gum. In all cases the mucilages prepared from the gums were strongly adhesive. The sample derived from *Acacia caffra* from Kontagora is interesting as showing that gum of good quality is obtainable in Nigeria from other species than *Acacia Senegal*.

MOROCCO.

The gum produced in Morocco is stated to be obtained from *Acacia arabica* and *Acacia gummifera*, although according to some authorities much of the gum now exported from that country is merely Senegal or Sudanese gum brought to Morocco by caravans from the interior. The gum is sold in Europe as "Morocco," "Mogadore" or "Brown Barbary gum." The tears are of moderate size, often vermiform, and of a fairly uniform light dusky brown tint; they show numerous superficial fissures.

In 1899 there were exported from Morocco (*via* the ports of Mogadore and Saffi) 450 tons of gum, and in 1900, from the same ports, 545 tons; but these quantities probably include other so-called gums in addition to gum arabic.

The following table shows the quantities and values of Morocco gum arabic imported in recent years into the United Kingdom.

Imports of Gum Arabic into the United Kingdom from Morocco.

Year.	Quantity in cwts.	Value in £.	Average price per cwt. £.
1899	422	833	1·97
1900	402	939	2·33
1901	796	2,025	2·5
1902	637	1,410	2·21
1903	1,451	3,666	2·52
1904	1,201	3,019	2·51
1905	1,731	3,861	2·23
1906	2,073	4,142	1·99

TRIPOLI.

There is a small but fairly regular export of gum arabic from Tripoli to France. No certain information is available as to the origin of this gum. In the period 1890 to 1900, the annual value of this export ranged from £150 to £250. There is no direct tax on gum.

TUNIS.

Small quantities of gum arabic are also produced in this part of Northern Africa, but nothing certain is known regarding its origin or the amount exported. The gum appears to be sent almost entirely to France.

GERMAN EAST AFRICA.

In this German Protectorate gum arabic is collected by the natives from *Acacia Senegal, A. Kirkii, A. spirocarpa, A. usambarensis*, and other species; at present most of it is used locally, but it is considered that this gum is likely to become an important article of export, especially to Germany, in the near future. Several specimens of German East African gum have been examined chemically, and very conflicting accounts of its properties have been published; some authorities state that it is only partially soluble in water, whilst others allege that it is similar to Senegal gum in quality. These differences are probably due to the admixture of the products of various acacia species.

No statistics of production, export or commercial value, are at present available.

GERMAN SOUTH-WEST AFRICA.

In this German colony a number of species of Acacia, viz. *Acacia horrida*, *Acacia stenocarpa* and *Acacia albida*, are known to occur, and gum is collected from these by the natives. It is as yet uncertain whether these gums will prove suitable for industrial use, and the remarks on the conflicting evidence on this point mentioned in the previous paragraph also apply to the gums produced in German South-West Africa. In this con-

nection it may be pointed out that *Acacia stenocarpa* is generally regarded as the source of some of the brown gum which appears in the poorer varieties (Gezira and Talh) of the Sudanese gum.

CAPE COLONY.

The gum produced in the Cape Colony is obtained from *Acacia horrida.* The export trade in this gum is small, and although small consignments of it are occasionally sent to the United Kingdom it does not command a ready sale.

ORANGE RIVER COLONY.

Acacia horrida also occurs in this colony, and gum is occasionally collected from it for local use. A sample of this material was received recently at the Imperial Institute for examination. It consisted of hard, brittle, pale yellow, sub-angular or irregular tears, and was free from dirt. On analysis the following results were obtained :—

	Per cent.
Ash	2·99
Moisture	13·06
Dry matter soluble in water	81·84

The mucilage was rather dark in colour, and was about twice as viscous as mucilage of good Sudan gum of similar strength. Its taste was sour and rather unpleasant, and the adhesive properties were poor. A firm of manufacturing confectioners to whom a sample of the gum was submitted stated that it resembled Aden gum, but would be of no value for confectionery on account of its marked taste. The sample was valued by brokers at 15*s.* per cwt.

SOMALILAND AND ABYSSINIA.

Aden and East Indian gum.

The gum produced in Abyssinia and Somaliland, especially in the districts of Gardafui and Ogaden, is exported from the coast towns on the Somali coast, principally to Aden and Bombay. From these two ports it is re-shipped to Europe as " Aden gum "

and "East Indian gum" respectively. Abyssinian gum is almost entirely exported *via* Harrar, and is subject to an export duty of 8 per cent. *ad valorem* on passing through that town.

It is impossible to say with certainty from what species this gum is obtained, but some of it is doubtless collected from *Acacia abyssinica* and *Acacia glaucophylla*, which are known to occur in those regions.

The best qualities of Aden and East Indian gum approach the better classes of Kordofan gums in appearance, solubility, etc., but these gums as a whole are darker in colour. The following tables show the extent of this trade.

Imports of Gum Arabic into Aden.

Year.	Quantity in cwts.	Value in Rupees.	Value in £.	Average Price per cwt. £ s. d.
1897–8	13,665	3,24,639	21,643	1 11 8
1898–9	10,155	2,67,086	17,806	1 15 0
1899–00	15,262	3,82,789	25,519	1 13 5
1900–1	11,516	3,45,480	23,032	2 0 0
1901–2	10,063	2,10,425	14,028	1 7 10
1902–3	3,491	58,145	3,876	1 2 2
1903–4	4,966	68,824	4,588	0 18 6
1904–5	4,093	51,502	3,433	0 16 9
1905–6	9,690	1,36,260	9,084	0 18 9

Exports of Gum Arabic from Aden.

Year.		Quantity in cwts.	Value in Rupees.	Value in £.	Average Price per cwt. £ s. d.
1897–8	to Foreign ports	11,384	3,89,575	25,972	2 5 7
	to Indian ,,	1,469	32,408	2,161	1 9 5
1898–9	to Foreign ,,	10,135	3,43,631	22,909	2 5 2
	to Indian ,,	607	13,675	912	1 10 0
1899–00	to Foreign ,,	14,261	4,86,007	32,400	2 5 4
	to Indian ,,	297	6,045	403	1 7 1
1900–1	to Foreign ,,	7,115	2,83,820	18,921	2 13 2
	to Indian ,,	2,374	94,960	6,351	2 13 6
1901–2	to Foreign ,,	6,140	1,76,121	11,741	1 18 3
	to Indian ,,	2,398	36,835	2,456	1 0 6
1902–3	to Foreign ,,	4,002	80,082	5,339	1 6 8
	to Indian ,,	618	8,467	564	0 18 3
1903–4	to Foreign ,,	3,576	67,858	4,524	1 5 4
	to Indian ,,	1,618	21,344	1,423	0 17 7
1904–5	to Foreign ,,	2,039	41,891	2,793	1 7 5
	to Indian ,,	3,700	62,020	4,135	1 2 4
1905–6	to Foreign ,,	1,758	36,117	2,408	1 7 5
	to Indian ,,	8,383	1,47,073	9,805	1 3 5

Imports of Gum Arabic into India.

Year.	Quantity in cwts.	Value in Rupees.	Value in £.	Average Price per cwt. £	s.	d.
1897–8	3,359	65,834	4,129	1	4	7
1898–9	2,841	59,531	3,969	1	7	7
1899–00	1,836	38,575	2,572	1	8	0
1900–1	2,355	49,879	3,325	1	8	3
1901–2	2,776	50,327	3,355	1	4	2
1902–3	1,146	21,494	1,433	1	5	0
1903–4	2,404	36,312	2,421	1	0	2
1904–5	4,691	62,860	4,191	0	17	10
1905–6	11,305	1,54,371	10,291	0	19	0

Re-exports of Gum Arabic from India (East Indian Gum).

Year.	Quantity in cwts.	Value in Rupees.	Value in £.	Average Price per cwt. £	s.	d.
1897–8	5,951	85,492	5,699	0	19	2
1898–9	7,297	1,05,801	7,053	0	19	4
1899–00	16,781	2,67,842	17,856	1	1	3
1900–1	12,171	1,61,355	10,757	0	17	8
1901–2	9,878	1,40,547	9,370	0	19	0
1902–3	10,704	1,47,044	9,803	0	18	4
1903–4	13,446	1,99,595	13,306	0	19	10
1904–5	8,147	1,32,245	8,816	1	1	8
1905–6	3,967	73,233	4,882	1	4	7

Throughout these tables 15 rupees have been taken as the equivalent of £1.

These tables are of interest as showing that the imports of gum arabic into Aden are approximately the same as the exports, whereas in the case of India the re-exports generally greatly exceed the imports. Three explanations of this fact have been given.

1. that the re-exports include gum brought across the land frontiers of India.
2. that the increase is due to the gradual accumulation of stocks of foreign gum in India, and
3. admixture with native Indian gum.

It is probable that the last-mentioned explanation is the true one, since no accumulation of stock would account for the continual excess of re-exports over imports shown by the tables given on the preceding pages; further, the import of gum arabic of the type of East Indian gum across the land frontiers of India

is very small, and even if included in the re-exports would not influence their amounts to the extent shown. The admixture with native Indian gum also accounts for the generally lower value of the re-exported product as compared with that of the imported gum. Gum arabic imported into India is subject to 5 per cent. duty *ad valorem*, and for tariff purposes the price of gum is taken at 15*s*. per cwt. A drawback equivalent to seven-eighths of the duty charged is allowed if the gum is re-exported within two years from the date of import.

INDIA.

Ghati gum.

This name is applied generally in India to the gum produced in India itself, as distinguished from East Indian gum of exotic origin. In European commerce, however, the name "Ghatti" or "Gatty" is practically restricted to the partially soluble and highly viscous gum derived from *Anogeissus latifolia* and certain other species. It is obtained from a great variety of trees, and no attempt is made to keep the products of the different species separate. The result of this is that consignments of Indian gum may vary considerably in properties. This state of things could be improved if a proper system of "sorting" and "grading" Indian gums were introduced, but so far nothing of this kind has been attempted on a scale large enough to modify its unsatisfactory character. Some of the more important sources of Indian gums are *Acacia modesta*, yielding the so-called "Amritsar gum;" *Acacia arabica*, furnishing "amrad" or "Amrawatti" gum; *Acacia Senegal; Odina Wodier*, furnishing "jingan" gum; *Anogeissus latifolia*, one of the principal sources of "Ghati" gum, and *Acacia catechu*.

The gums yielded by these trees appear to be collected in India in a very haphazard fashion; thus Captain Tighe in his Report on South Baluchistan (*Agricultural Ledger*, 1902, No. 2, p. 76) states, with regard to the gum of *Acacia Senegal:* "There is no regular collection of the gum. Women and children occasionally collect a little and barter it to the banias for anything they may want. The latter accumulate whatever is brought until they have sufficient to take to Karachi. The collection is thus made casually by banias, who sell it to the leading native

firms in Karachi, who in turn sell it to the European merchant." In some cases gum collectors are charged a nominal sum (usually one anna per day) for the privilege of collecting forest produce, including gum in the conserved areas, but apart from this no taxes are levied.

In spite of these unsatisfactory conditions, the trade in Indian gum has assumed considerable dimensions, and if steps were taken to encourage the growth of a few of the best gum-yielding species, and a proper system of collecting, sorting and grading the gums were instituted, there can be no doubt that a large export trade could be developed.

A number of samples of Indian gums have been examined at the Imperial Institute, and the results obtained with the more important of these are given in the table on the following page.

These results are of little interest from a commercial point of view, since Indian gum of commerce consists generally of mixtures of the products of different species; but they are interesting as showing that it would be advantageous to keep these products separate. Of the nine gums examined, probably five, viz. those from *Prunus eburnea*, *Acacia Jacquemontii*, and *Elæodendron glaucum*, would rank commercially as gums of the first grade, whilst those from *A. catechu*, *A. arabica*, *A. Farnesiana* and *A. modesta* would probably sell as second-grade products. The results obtained with *Anogeissus latifolia* gum are similar to those obtained with the best grades of Ghati gum which reach the United Kingdom. Analyses of the gums of *Bauhinia retusa* and *Odina Wodier* have already been published in "Technical Reports and Scientific Papers" issued by the Imperial Institute in 1903. These are both soluble gums of the second grade.

The following table shows the quantities and values of Indian gum arabic (Ghati gum) exported in recent years.

Year.	Quantity in cwts.	Value in Rupees.	Value in £.	Average price per cwt. £	s.	d.
1899–00 .	46,254	7,70,947	51,396	1	2	3
1900–1 .	37,553	6,99,883	46,659	1	4	10
1901–2 .	55,941	7,54,719	50,315	0	18	0
1902–3 .	38,019	4,54,639	30,309	0	15	11
1903–4 .	39,760	5,02,486	33,499	0	16	10
1904–5 .	28,377	4,34,604	28,974	1	0	5

Results of Examination.

	Acacia Jacquemontii. From Amritsar.	*Acacia Jacquemontii.* From the Punjaub.	*Acacia Jacquemontii.* From the Punjaub.	*Prunus eburnea.* From Baluchistan.		*Elæodendron glaucum.*	*Acacia catechu.*		*Acacia arabica.*	*Acacia Farnesiana.*	*Acacia modesta.*	*Acacia Senegal.*	*Anogeissus latifolia.*	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	18·5	18·5	14·8	14·8	14·7	15·2	15·7	16·8	15·0	13·8	16·2	16·3	15·5	16·1
Ash . . .	3·53	3·5	2·84	2·54	2·35	2·59	3·24	2·87	2·27	1·83	2·69	2·68	2·41	3·11
Dry matter soluble in water . .	80·02	81·9	84·0	80·7	79·1	82·0	82·4	81·2	78·6	85·40	85·0	84·0	78·2	71·5
Acidity* . .	4·0	3·2	4·8	0·8	1·2	—	—	—	—	—	—	—	—	—
Character of Mucilage .	Faintly opaque, slightly yellow, adhesive.	Clear, faintly yellow.	Slightly yellow.	Fine clear colourless adhesive solution.		Clear, very slightly yellow.	Clear, light reddish-brown.	Light yellowish-brown.	Clear, pale reddish-brown.	Clear, pale yellowish-brown.	Clear, pale yellow.	Clear, faintly yellowish-red.	Viscid, pale yellowish-brown.	Viscid yellow solution.

* *Milligrams of potassium hydroxide required for one gram of gum.*

The principal markets for Ghati gum in order of their importance are Germany, the United Kingdom, Belgium, and France; the imports into the last-mentioned country have risen steadily from 2,322 cwts. in 1900–1 to 4,279 cwts. in 1902–3.

AUSTRALIA.

Throughout the Commonwealth of Australia gum is collected from various species of Acacia known locally as "Wattles." The principal species are *Acacia pycnantha*, *Acacia decurrens*, *Acacia neriifolia*, and *Acacia homalophylla*. Wattle gum occurs in large hard globular tears occasionally of a pale yellow colour, but usually amber or reddish-brown. It is transparent and highly adhesive, and is therefore particularly suitable for adhesive purposes. These gums are extensively used in Australia, and were formerly exported in considerable quantities to the United Kingdom and Germany. The imports of wattle gum into the United Kingdom in recent years are shown in the following table:—

Year.	Quantity in cwts.	Value in £.	Average price per cwt. £	s.	d.
1897	1,063	1,667	1	11	4
1898	2,150	3,368	1	11	4
1899	2,186	2,593	1	3	8
1900	1,192	1,668	1	7	11
1901	620	815	1	6	3
1902	248	300	1	4	2
1903	263	379	1	8	10
1904	91	119	1	6	2
1905	97	112	1	3	1

The imports came at first principally from New South Wales, but recently South Australia has taken the largest share in this trade. The foregoing table shows that the consumption of wattle gum is declining in the United Kingdom, but it is impossible to say whether this is also the case in other countries, or whether the production of gum in Australia has decreased, since the trade returns of the Commonwealth do not distinguish "wattle" from other so-called gums such as sandarac and xanthorrhœa resins, and no statistics of production are available.

OTHER LOCALITIES.

Small samples of gums have been received at the Imperial Institute from other localities from time to time for examination, notably Uganda, Nyasaland, Portuguese East Africa, and Southern Nigeria, but these have in all cases been incompletely soluble or too dark in colour to be suitable for commercial exploitation.

PRODUCTION OF THE INSOLUBLE GUMS.

Gum tragacanth, which is the most important member of the insoluble gums, is the product of various species of Astragalus which grow wild as shrubs in many localities in Asia Minor, Kurdistan, and Persia; some is also obtained in Greece from *Astragalus cylleneus*. The best gum is obtained from artificial incisions in the stems, but naturally occurring exudations are also collected. The shape of the incision determines the form of the pieces; thus longitudinal incisions yield leaf-shaped tragacanth, and punctures yield thread tragacanth. The gum exudes in a pasty state, and if the weather is calm and dry the product is at its best and is ready for gathering in three or four days.

Smyrna and Baghdad are important centres from which it is exported, and at Smyrna it is sorted into various qualities. The exports from Smyrna are reported as "gum tragacanth," whilst those from Baghdad and its port Basra, near the mouth of the Euphrates, are reported as "gum," which includes some tragacanth, but consists largely of what is known in trade as Persian insoluble gum. The exports are given in the following tables. The weight of packages is not stated, but they probably hold quantities approaching 2 cwt.

Exports of Gum Tragacanth from Smyrna.

Year.	Cwt.	Value in £.
1901	1,660	4,046
1902	3,000	9,577
1903	2,600	6,237
1904	2,300	5,104

Exports of Gum from Basra.

Year.	Packages.	Value in £.
1901	5,593	22,372
1902	6,098	24,392
1903	6,537	26,148
1904	7,683	30,732
1905	7,679	30,716

The prices quoted for gum tragacanth in the London market vary from £2 10*s.* to £14 per cwt.

Various other insoluble gums are collected in different parts of the world, but they are not so highly valued as tragacanth. In India the gums of *Cochlospermum Gossypium* and of *Sterculia urens* are sold as a substitute for tragacanth. An examination of the gum of *Cochlospermum Gossypium* has been made by Mr. H. H. Robinson in the laboratories of the Imperial Institute, and the results were communicated at the York meeting of the British Association for the Advancement of Science, and a fuller account of the investigation was published in the *Journal of the Chemical Society* (1906, **89**. 1496). *Cochlospermum Gossypium* is a small deciduous tree belonging to the Bixiniæ; it grows abundantly in the forests of the North-West Himalaya, and extends across the central tableland of India. The gum occurs in irregular, rounded, translucent lumps of a pale buff colour; like tragacanth, it absorbs a large quantity of water and swells to many times its original size. It is remarkable among the gums for its property of slowly giving off acetic acid when exposed to moist air; this property is also possessed by the gum of *Sterculia urens.* The gum was found to yield 14 per cent. of acetic acid; unlike tragacanth, it does not give any blue coloration with iodine, and is therefore free from starch.

By the action of cold 5 per cent. sodium hydroxide solution a solution of the gum is obtained which, when neutralised with acid and submitted to dialysis, yields a clear viscous liquid containing a substance which has been named "cochlosperminic acid." If the viscous liquid is evaporated, clear transparent flakes are obtained which resemble the original gum in being insoluble in water, but no longer contain acetic acid, as this acid has been removed by the sodium hydroxide.

By the action of hot dilute sulphuric acid the gum is decomposed into acetic acid, various sugars and a nucleus acid, gondic acid, which, like gum arabic, is soluble in water and possesses adhesive properties.

This work suggests the possibility of preparing products of industrial value by the chemical treatment of various Indian gums of this type.

COTTON GROWING IN CENTRAL ASIA.

THE methods of cotton cultivation and the state of the cotton-growing industry in various parts of the world have been described in a series of articles in previous numbers of this *Bulletin*. In continuation of this series the present account deals with the industry in Central Asia, where it has been established from very early times; the particulars are, for the most part, derived from a paper in the *Tropenpflanzer* (1907, **11**. 679), by Herr V. Walta.

When that part of Asia was under the rule of the Khans the great importance of cotton growing was recognised, and enactments were made ordering that a proportion of the irrigable land should be planted with cotton, and that a tenth part of the yield should be paid to the Khans, the payment being usually made in kind; further, a somewhat high tax was imposed on every camel-load of cotton that left their boundaries. After Skobeleff's victorious campaign in 1881, which considerably increased the dominions of the Tsar, cotton cultivation greatly diminished, as the natives no longer obeyed their former rulers. Thus, at the beginning of the seventies in the last century the Fergana district exported to Russia alone about 11,000,000 lb., whilst in 1883, after the Russian occupation, only about 700,000 lb. were exported.

After the Russians had directed the robber tribes into peaceful paths, the inhabitants again took to cotton growing, the industry being now assisted by the laying out of irrigation canals, and

by reduction in the taxes. It was soon found that, owing to its inferior quality, the cotton was not up to the standard required by the spinning mills; the Russian Government, therefore, endeavoured to introduce new varieties of the cotton plant in order to raise both the quality and the yield; cultivation experiments were also established. Unfortunately, the species selected for trial was Sea Island cotton, which proved a failure. As this plant only thrives in warm damp climates there was no possibility of its succeeding in Tashkent, where it was tried. Notwithstanding this failure, General Kaufmann still adhered to the idea of introducing American seed, and by his advice two farmers were sent to study cotton growing in North America. On their return the cultivation experiments at Tashkent were prosecuted with renewed energy, and it was discovered that Upland cotton was the right variety to grow.

In the year 1883 the experiment station was closed, since a new Governor-General considered it better not to institute any scientific experiments, but to distribute American cotton seed directly to the natives. This somewhat costly undertaking led to no result, since the people were unacquainted with the way to cultivate the new variety; the failure was also partially due to Sea Island seed having been distributed under the name of Upland.

In the year 1884 N. O. Rosenbach was appointed Governor of Turkestan, and the use of American varieties revived and met with unexpected success. The Government gave good Upland seed free to the cotton growers, and distributed directions as to the proper methods of cultivation printed in the local languages. An experiment station was again established in Tashkent with the object of carrying on cultivation experiments with different American varieties, of studying the animal and vegetable pests of the cotton plant, and of affording a model to the natives of the right methods of growing cotton. Every year meetings of cotton farmers were held to exchange an account of their experiences, and to agree upon measures for improving cotton cultivation. The success of the methods adopted under Rosenbach is shown by the rapid increase in the areas planted with American seed, as appears in the following table:—

1884	815	acres of American cotton.
1886	32,620	„ „ „
1888	101,190	„ „ „
1890	159,980	„ „ „

In 1890 the total crop in Turkestan was 924,000 poods (14,900 tons) of American cotton, and 358,000 poods (5,770 tons) of Asiatic cotton. At the present time the annual crop of cotton in the Central Asiatic possessions is estimated at about 6,000,000 poods (97,000 tons).

As is usual in the interior of continents, the climate of the cotton-growing districts of Central Asia is characterised by excessive heat in summer, and a considerable degree of cold in winter. At the Tsar's estate at Bairam Ali in Merv, the extremes of 113° F. and − 8° F. have been observed. Although autumn frosts often set in at the end of September, yet the great heat of the summer is sufficent to ripen subtropical crops such as cotton and rice; there are some places, too, which are quite free from frost in the early autumn and late spring.

As regards rainfall, the country is not so well off; thus in the most favourable situations, such as Askabad, the fall only amounts to 11 inches per annum, whilst further from the mountains falls of 5 inches or so per annum are recorded. Most of the rain falls at a time when the temperature is too low for sowing, cotton seed requiring a soil temperature of at least 59° F. for germination to take place; it thus happens that the sowing has to be done not long before the dry period sets in. Consequently, the lack of rain is much felt in the early period of growth, and irrigation is essential at this period and up to the time of flowering. Further, the harvest comes in the rainy period, and is thus liable to considerable loss.

The soils of Turkestan are not bad, and, provided that the supply of water is sufficient, are capable of cultivation. They are generally described as "loess," but "loess" is usually understood to mean a deposit formed by the drifting action of the wind, and this is not to be taken as the meaning of the word when applied to the Turkestan soils. They are believed to be river and lake deposits, and differ but little from true loess in their composition and properties; they may be described as loess-like

loam. True loam, it has been stated, is only to be found in the centre of the course of the river Murghab and on the northern border of the Murghab oasis. The surface soil of the so-called loess is composed of a yellow material, somewhat darkened by humus, which, however, rarely exceeds 2 per cent.; it is penetrated by tiny tubes left by the decay of roots. A sample of soil from the neighbourhood of Tashkent was found, on analysis, to have the following composition :—

		Per cent.
Sand	SiO_2	65
Calcium carbonate	$CaCO_3$	7·15
Potash	K_2O	2·8
Phosphoric anhydride	P_2O_5	0·28
Iron oxide	Fe_2O_3	3·6
Capacity for water		38·4

Samples of soil collected by the explorer Przevalski on the route from Tashkent to Verny varied greatly in composition, as is shown in the following table :—

		Minimum. *Per cent.*	Maximum. *Per cent.*
Phosphoric anhydride	P_2O_5	0·05	0·35
Nitrogen	N	0·006	1·7
Potash	K_2O	0·1	1·6
Calcium carbonate	$CaCO_3$	5·65	67·37

The deeper layers of the soil are characterised by clay and salt, and not infrequently a heavy rainfall is followed by an efflorescence of salt on the surface. The high proportion of salt, however, is not injurious to the cotton plant—in fact, the superior quality of the cotton fibre from the Khanate of Khiva is ascribed to the saltness of the soil.

Although certain sterile tracts of sand and pebbles occur, yet in general the soil may be considered to be highly fertile. It is poor in humus owing to the dry climate, but the high proportion of calcium carbonate is a point of advantage, and the proportion of the other mineral constituents necessary for plant growth is fairly large.

The methods of agriculture practised by the natives are extremely primitive, and the fields are worked as they have been for the last thousand years, with the exception that more attention is paid to irrigation. A rudimentary form of plough known as the "omatch" is in use; it is very cheap, costing, inclusive of the cast iron ploughshare, only three shillings. Camels, buffaloes, oxen, or horses are harnessed to it in varied combinations, and it is drawn in serpentine tracks in all directions over the field. Only the Russians use iron ploughs. The harrow consists of a board armed with iron nails; when in use a man stands on the board to give it weight and prevent it jumping over the clods. Very often the "omatch" is laid on its side and dragged over the ground to serve as a harrow. A rough hand-hoe, the "ketmen," is an implement in universal use among the Turcomans.

The farming operations are carried on in the following order:—(1) Irrigation of the fields in autumn; (2) ploughing; (3) ploughing and harrowing in the spring; (4) making up beds for the seed; (5) irrigating; (6) sowing; (7) irrigating; (8) thinning the seedlings, hoeing, and weeding; (9) irrigating; (10) a second hoeing; (11) irrigating; (12) a third hoeing; (13) removing the top and side shoots; (14) harvesting.

The autumn ploughing is not a general practice, for the most part of it is only done by the Russian colonists and the larger landed proprietors. When stubble has to be broken up or the land ploughed before the commencement of the rains, a preliminary irrigation is necessary, otherwise the land is too hard for the plough to break up. The depth of the autumn ploughing is 6 to 8 inches. For the spring ploughing a preliminary irrigation is not required, since the fields retain sufficient of the winter's moisture; this ploughing is begun in the middle of February, or at the latest in the beginning of March; it is repeated many times and in various directions, since experience has shown that the cotton plant requires a well-prepared seed bed. On small farms worked by the natives a good deal of hand-hoeing is done in course of preparing the land.

But little attention is paid to manuring; owing to the fertility of the soil and of the silt brought by the irrigation water it has been possible hitherto to grow cotton for several years in succes-

sion on the same field. Stable manure is only to be obtained in the larger towns and villages, and when it is used 4 tons per acre is the most that is applied. The manure most valued and most in use is mud dug from the canals, old wall rubbish, and the like. Recently here and there the ashes of the cotton stems, which are in great request as fuel, have been spread on the fields. Experiments with superphosphate have so far given very good results, and it is hoped that the use of artificial manures will raise the yields, which are now yearly decreasing.

When the field is ready the seed bed is prepared by means of the plough or hand-hoe; the ridge, as a rule, is made about 30 inches broad and from 11 to 18 inches high. The Russian settlers form the beds in straight lines parallel to one another, whilst the natives prefer zigzags or wavy lines. If the supply of water is ample the latter plan possesses decided advantages, since the water flows more slowly through the furrows and supplies more moisture to the soil. Beds are not always prepared for the seed—the Sarts of Samarkand sow their seed broadcast after the field has been evenly flooded; but even here some progress is being made, and the natives are beginning to see the advantages of making seed beds, and that the plants then suffer less injury from the irrigation. By making raised seed beds the surface soil escapes getting wet, and consequently remains of a looser texture; the water only wets the deeper layers; the soil in the neighbourhood of the plants is not so quickly cooled, and the water evaporates to a much less degree than when the seed is sown broadcast on a flat surface. An irrigation just before sowing is only requisite if the soil is deficient in moisture; fortunately, this is rarely the case, as in April, the sowing time, the rainfall is sufficient.

The seed ordinarily used is two years old, as experience has shown that it then germinates more regularly. Before sowing it is soaked in water for about 12 hours, and is then taken out and rolled in ashes, until the seeds are completely coated; this is done to ward off insect attacks. Soaking in liquid manure is found to have a bad effect, and consequently is rarely employed.

From 90 to 150 lb. of seed are sown per acre, and from 20 to 30 seeds are placed in shallow holes so that the united strength

of the seedlings can break through the surface soil, which, being like loess, is apt to form crusts. Later the plants are thinned, the strongest being preserved. Thinning, weeding, and hoeing the beds is completed before the next irrigation, which is given three or four weeks later according to the weather. In irrigating the water is made to run in the furrows in a thin stream so that the soil is slowly moistened and only in the lower layers; in this way the formation of crusts and the rapid cooling of the earth are avoided. Hoeing and weeding are almost entirely done by hand; there are very few hoeing machines, and these are only to be found on the larger Russian estates.

In the course of hoeing the earth is heaped up round the plants; the soil is kept loose by two or three more hoeings, and two or three irrigations, according to the weather, are given in the course of the summer, namely, at the beginning of May, in the middle of June, and at the beginning of July. These are enough if the land has been ploughed deeply, but in the case of shallow-ploughed hard and dry soils four or five irrigations are requisite.

Flowering usually begins in the middle of June, the lowest branches unfolding their blossoms first and the uppermost buds opening latest. No further hoeing is given, but when flowering is at its height, which usually happens in the first half of July, a final irrigation is given. At this time the ends of the stem and twigs are removed with the object of getting a uniform ripening of the capsules. This plan is especially favoured in the neighbourhood of Tashkent and in the district of Fergana, but a great part of the cotton farmers are reluctant to clip off the growing ends, since they believe the uppermost capsules will still ripen; this, however, is rarely the case, since the uppermost buds come very late and are quite the last to flower, and the capsules as a rule are nipped by the early autumn frosts and do not ripen.

After the middle of July all work ceases on the plantation, and the owners prepare for the coming harvest. Under the scorching rays of the July sun the capsules soon become brown and open and allow the snow-white flocks of cotton to emerge. This, however, is not the case with the Asiatic varieties of the plant, since they open only to a small extent at the tip. At this period a watch must be kept on the fields, in order to

prevent depredations, which are so common that an unguarded plantation may be seriously plundered in a single night.

On the large plantations labourers are engaged to gather the cotton from the capsules, and they are paid either by the day or by the weight of cotton gathered. The native farmers gather the cotton themselves, enlisting the help of their whole family, including the children. In the case of the indigenous cotton the whole capsules have to be picked off, which makes the harvesting much more troublesome. The harvest lasts some time, since the capsules ripen very irregularly and the field has to be gone through over and over again; it continues even after the first autumn frosts, for there are often warm days during which capsules of American cotton may still open and ripen; this cotton is, however, of poorer quality, since it is often injured by rain. The months of September and October are critical for the cotton harvest—if warm, dry weather prevails, the harvest is abundant and the lint is of first-class quality; but if early frosts occur, the harvest is poor, and the fibre injured by frost fetches only a low price.

In the Namangan district, at the beginning of the harvest, 9*d.* or 10*d.* is paid for picking 100 lb. of seed cotton; at the end of the harvest the rate rises to 14*d.* At Tashkent, where the lack of labour is much felt, labourers have to be engaged by the day, and the cost of harvesting is much higher. Apart from these extreme fluctuations the average yield may be taken as 980 lb. of seed cotton per acre, and the cost of picking it as 7*s.* 6*d.* to 8*s.* Such a crop is considered satisfactory, but if the cost of labour rises, and the prices in the market are low, the profit becomes very doubtful. There is no doubt that by better cultivation the yield could easily be improved.

The stems remaining in the field are pulled up in the late autumn and made into bundles for use as fuel; they are either used on the farm or sold in the market, where they fetch 3*s.* 5*d.* to 4*s.* 4*d.* for the produce of an acre.

The cleaning of the native variety of cotton is very tedious; the capsules must be broken by hand, and the seed cotton plucked out; the latter is then ginned in the "chigrich," which is a primitive form of cotton gin after a pattern derived from India. In this machine some of the seeds get crushed, and the fibre has

to be beaten to produce a marketable article, which even then is in poor condition. The extraction of the cotton from the capsules begins in the late autumn, being carried on in the evenings by the native farmers and their families, old people and the children of others being also engaged to assist. Sometimes it is done by more capable workers, who receive half the cotton seed in lieu of payment. It takes a home-worker at least a week to break open 220 lb. of capsules and to gin the cotton with the "chigrich," and for this he receives daily about 12 lb. of seed, worth *2d.* to *3d.* From 100 lb. of capsules there is usually obtained :—

$22\frac{1}{2}$ lb. of fibre,
$22\frac{1}{2}$ „ „ capsule shells,
$52\frac{1}{2}$ „ „ seed,
$2\frac{1}{2}$ „ „ loss.

Although the work is extremely laborious and slow, yet the natives take but little advantage of the ginning machines which have been established in many places, and the "chigrich" will remain in favour for a long time, especially as it only costs about *5d.* and thus can be bought by the poorest cotton farmer. The indolence of the natives and the distance and difficulties of transport by road are hindrances to a general use of the ginneries, although the latter do the work more cheaply and give a cleaner product. The circumstances that the natives produce only small quantities of cotton, which can be easily worked up by the family; and that labour is very cheap and can be paid for by cotton seed instead of by money, also tell in favour of the "chigrich."

The ginning machines established at the larger centres are usually driven by water-power, and have hydraulic or screw-baling presses worked in conjunction with them. Recently a feeding apparatus and also a condenser have come into use as adjuncts to the gin; the latter collects the cleaned fibre and presses it into a broad band; before its use the cotton dust suspended in the air often gave rise to explosions, and, further, the collection of the cleaned cotton strewed over the whole room was no light task. The cotton farmers, however, believe that by the use of the condensers the yield of cleaned fibre is smaller, and that they suffer a loss in consequence.

The distribution of the ginneries in the different cotton districts is very irregular, thus there are many in Tashkent and Andishan, whilst in Khojent there are few. The ginning and pressing is a profitable business. The charges for ginning the fibre are not the same everywhere; they are at the highest during the autumn season, and the number of ginneries has a great influence on the prices to be paid. On the average they may be taken as from *7d.* to 12½*d.* per 100 lb. of seed cotton. A further charge is made for pressing into bales, fastening with iron bands, and covering with packing-cloth.

The cotton is sorted into three qualities: a first quality, composed of the white fibre from all the crops; a second quality, composed of yellowish fibre and such as has suffered only slightly from frost; and a third quality, of grey or full-yellow fibre which has been injured by frost or rain. Other plans of sorting are very rarely undertaken, and consequently Central Asiatic cotton is unable to rule successfully the Russian market. Some large firms, however, which possess their own plantations and spinning mills are taking great pains, in conjunction with the Moscow Exchange Committee, to guide the sorting in the right lines; the chief efforts are directed to sort and value the cotton according to its strength, colour, length, and softness. The founding of the Cotton Institution in Tashkent in 1891 was a step towards a more exact study of the properties of cotton fibre.

The seed is used both for fuel and as a source of oil. The custom of burning it as fuel is fairly widely spread in Central Asia, all the seed unsuitable for sowing or pressing being employed for this purpose. Barracks, garrison kitchens and private houses are almost exclusively heated by cotton seed. Any ordinary stove can be used for this fuel, but a special arrangement to increase the draught must be provided, since with a moderate supply of air the seeds char only slowly. From 1½*d.* to 3½*d.* per 100 lb. are paid for the seed for heating. When used for pressing for oil the shells of the seeds are removed, since the hairs on the seeds greatly increase the difficulty of getting the oil. Cotton seed is in request to mix with other seeds, as when pressed together the resulting cake has a looser consistency; a mixed sesame and cotton seed cake is highly

prized in Turkestan as a cattle food. Cotton seed is delivered at the oil mills at from 5½*d.* to 7*d.* per 100 lb.

Large firms buy the cotton from American seed in the unginned state, but the native variety only after it has been ginned by the "chigrich;" this latter kind is rarely sold unginned in its capsules, as it is so troublesome to prepare the fibre from it. The manufacturers of Poland and West Russia who are not in close touch with the Asiatic markets buy the cotton through travelling agents or through the firms mentioned above. The principal business is done in Fergana, since it is easiest to buy up large lots of cotton in a short time there. Besides purchase for ready money, numerous other arrangements are in use between the buyers and producers. On the whole the terms are not particularly hard, for, owing to the high import duty on American cotton, it is important for the Russian firms to stimulate cotton cultivation among the natives, and in this way to secure larger and cheaper supplies.

There are two routes by which the cotton reaches European Russia: the northern route is by rail from Tashkent through the town of Turkestan to Orenburg and Samara, where it joins the railways of European Russia; the southern route is over the Trans-Caspian military railway, which goes through Samarkand, Merv and Askabad to Krasnovodsk on the Caspian Sea, whence the bales can go by steamer either up the Volga, or to Baku and then by rail to Batum or Poti on the Black Sea. The transport of the cotton from the interior to the chief stations, however, is beset with great difficulties; it is effected either by two-wheeled carts or by camels. In autumn and winter the loess-like soil is changed after heavy rainstorms into a sticky mass, and communication on the country roads is often completely interrupted, and the caravan drivers are apt to throw the bales of cotton in the mud and decline to take them further. In such weather camels are preferable, since they make better progress on the soft roads than buffalo- or ox-carts. As regards the rate of transport, it may be mentioned that on good roads an ox-cart or a camel can go about 2½ to 3 miles an hour.

The following estimates give an idea of the cost and profits of cotton growing in different localities in Central Asia.

The cost of growing cotton from American seed in the Namangan circuit in the Fergana district is as follows:—

	Cost per acre in shillings.
Manure: purchase, transport and spreading	2·08 to 4·92
First ploughing	1·23 „ 3·08
Second ploughing	1·15 „ 2·31
Third ploughing and harrowing	1·54 „ 2·69
Preparing the seed beds	2·88 „ 5·38
Sowing	0·92 „ 1·15
Value of the seed	0·46 „ 0·46
Irrigating four to five times	0·92 „ 1·34
Hoeing (loosening the soil and weeding four to six times)	13·84 „ 18·84
Thinning	1·15 „ 1·62
Harvesting (590 to 890 lb. of seed cotton)	3·69 „ 6·46
Management	3·84 „ 12·30
	33·70 „ 60·55

Away from the towns and garrisons manure is not obtainable; if the cost of this be deducted and 1·54*s.* is added for land tax the cost of cultivation amounts to from 33*s.* to 57*s.* per acre.

To this must be added the following charges:—

	Cost per acre in shillings.
Rent of the land	7·70
Ginning the seed cotton (890 lb.)	3·84
Transport to the ginnery	3·08
Baling and weighing	3·08
	17·70

The total expenses thus amount to from 51*s.* to 75*s.*, with an average of 63*s.* per acre. Taking the average yield of ginned cotton as 15 to 18 poods of 36·11 lb. each per desatine of 2·7 acres, the yield per acre is 200 lb. to 240 lb. Taking 7½ roubles per pood as an average price, and the value of a rouble to be 2·16 shillings, the price per lb. is 5·4*d.* and the gross receipts are 90*s.* to 108*s.* per acre. The net profit is estimated at 30 to 50 roubles per desatine, or 24*s.* to 40*s.* per acre.

In the case of natives and of small farmers, who do all the work themselves, the cash expenditure is very small, and the net profit is much higher than it is for larger owners who have to employ hired labour.

In Tashkent the conditions are not so favourable as in Fergana; frosts come comparatively early in the autumn, so that the quality of the cotton is variable, the costs of production are higher, and the net profit is estimated at only 5*s.* to 19*s.* per acre.

All the above estimates apply only to cotton grown from American varieties of the plant. As regards the native variety of cotton plant, taking the cultivation by natives in Samarkand as an example, the expenses amount to:—

	Cost per acre in shillings.
Manuring (if practised)	2·02 to 8·09
Working the soil	9·71
Seed	1·62
Sowing, irrigating, hoeing . .	13·76
Harvesting	6·47
	33·58 to 39·65

If the average yield of capsules is 1,800 lb. per acre and the price is 0·65*d.* per lb., the gross receipts are 97*s.* and the net profits are about 60*s.* per acre; but the yield of capsules does not always reach this amount, and manure is not always used, so a more likely estimate is 890 lb. of capsules per acre with 28*s.* as the cost of production, resulting in a net profit of 20*s.* per acre. This average can also be taken as applicable to Fergana, where much native cotton is grown.

The following general conclusions can be drawn regarding cotton cultivation in Central Asia.

1. A high net profit is sometimes obtained, and in any case the cultivation is not attended with the losses that are often met with in the case of other crops.

2. The amount of the gross receipts is liable to great variation, and the crop harvested is extremely dependent on the weather, especially that of the months of September, October and

November. If autumn frosts keep off there is a chance for the upper capsules to form fibre and ripen.

3. The climatic conditions are especially unfavourable in Tashkent; they are better in Fergana, and still better in the Sarevshan district, where the autumn frosts set in late.

4. In comparison with other crops, such as lucerne, maize, earthnuts, jugara (a kind of sorghum), and rice, the net profit from cotton is not considerable, as these crops as a rule give 16*s.*, 20*s.*, and even 32*s.* per acre, and consequently under certain circumstances are more profitable than cotton.

The inducement to grow cotton is thus not very enticing, but there is still room for improvement in the direction of lowering the cost of production and raising the yields. The ploughing should be improved, especially as the loess-like soil requires to be thoroughly well ploughed; a rotation of crops should be tried instead of growing cotton after cotton; more attention should be paid to manuring—its use is but little understood, and when used the manure is of such poor quality that not much benefit can be expected from it; further, the poverty and indolence of the natives stand in the way of its purchase.

The cotton growers depend to a great extent on advances to enable them to carry on the cultivation; and improvements in the conditions of making the advances should be effected either by the State or by associations of cotton sellers. The railways are not always in a condition to deal adequately with the transport of cotton; and the stations are so far from the cotton districts that the cost of transport in bringing the cotton to the railway is much increased. Last year a steamship company was formed for the Aral Sea, which will be of great importance in opening up the cotton districts of the Khanate of Khiva.

In one instance a landowner in the neighbourhood of Khojent by means of an oil motor was enabled to pump up water and irrigate some hundreds of acres of land which had previously been barren, and he is now in treaty with the Government with a view to acquiring further land. His example is being followed by neighbouring proprietors, with the effect of transforming poor sheep pasturage into cotton fields. This shows that great benefits would arise from more attention being paid to irrigation. Already here and there, by the construction of systems of

irrigation, such as that on the Tsar's estate at Bairam Ali in Merv, large areas of barren land have been rendered fertile and produce peaches and apricots, which reach the Moscow market in the dry state in large quantities.

In conclusion, it may certainly be expected that the Central Asiatic territory will be quite able to meet Russia's demand for cotton, and thus free her from dependence on the American cotton market. The cotton-growing industry there has many points of advantage over that in the United States: the inhabitants are more moderate in their demands, and labour is consequently cheaper; the rent of land is not high, and the yields admit of considerable increase by the adoption of better methods of cultivation. Difficulties due to the climate, which are a great disadvantage to Central Asia and which trouble the American farmer but little, may be met by breeding varieties adapted to the local conditions. So far but little has been done in this direction, and such work will be of great importance in the future.

WEIGHT AS A FACTOR IN SEED SELECTION, WITH SPECIAL REFERENCE TO COTTON SEED.

ALTHOUGH it has long been known that the heaviness of the seed used for sowing is closely connected with the vigour of the resulting plants and with the yield and quality of the crops, yet this point does not appear to have received so much attention from agriculturists as it undoubtedly deserves. It has been shown by numerous investigators, both in Europe and America, that, under similar conditions, larger crops of the cereals are produced from heavy seed than from lighter seed of the same variety, and the fact has been established that in most, if not all cases, the time, labour and expenditure involved in the selection of heavy seed for planting are amply repaid by the enhanced value of the crops.

The superiority of heavy seed is, of course, due to the larger quantity of reserve-material which it contains, and which is available for the nourishment of the plant, thereby enabling it

to develop more rapidly, and endowing it with more vigour and disease-resisting power.

The following are some of the chief advantages gained by the use of heavy seed. The seeds usually germinate more quickly and produce hardier and more vigorous plants than the lighter seeds, and the crops produced are larger and more uniform. These facts were strikingly brought out by experiments which were carried out in a greenhouse some years ago by Messrs. Gilbert H. Hicks and John C. Dabney, and described in the *Yearbook of the United States Department of Agriculture*, 1896, p. 305. The seeds then tested were those of garden peas, beans, hairy vetch, rye, barley, wheat and oats. In each case two specimens were carefully selected, one of heavy, the other of light seed, the individual seeds of each specimen having approximately the same weight. The seeds were sown in pure sand, and the plants from each specimen were given equal quantities of a culture solution containing all the necessary elements of plant food. They were kept under exactly the same conditions, and at the conclusion of each experiment typical plants from each set were carefully removed, and weighed and measured. In every instance the seedlings from the heavier seed were of greater weight, the difference being closely proportional to the difference between the weights of the seeds. Seedlings from the heavier seeds exhibited greater vigour, were taller, bore a larger number of leaves, and had thicker stems and better-developed roots. The plants made better growth in every way, and produced larger and earlier crops than those from the lighter seeds.

Similar results have been obtained with tobacco seed. Comparative tests, which were made by Mr. A. D. Shamel (*Yearbook of the United States Department of Agriculture*, 1904, p. 440), showed that the large, heavy seed always yielded the best-developed and most vigorous plants, whilst the light seed furnished small, weak, and irregular plants. A sample of Cuban seed was separated into three grades—light, medium, and heavy. The heavy seed germinated almost perfectly, whereas less than 5 per cent. of the light seed germinated. The plants from the heavy seed grew more rapidly than those from the light seed, and were ready for transplanting seven to nine days earlier than

the latter. The plants from the heavier seed were also hardier and more uniform.

The separation of the heavier and larger seeds is most commonly effected by means of sieves of suitable mesh. A partial separation can also be made by throwing the seed into water or a solution of salt, allowing the heavy seeds to settle, and skimming off and rejecting the lighter seeds. This plan is not altogether satisfactory owing to the adhesion of air-bubbles to some of the heavy seeds, thereby rendering them buoyant. The seeds must be immediately dried after removal from the liquid. Another method, and one which was successfully employed in the separation of the tobacco seed used for the experiments mentioned above, depends on the use of a current of air. A foot-bellows is connected by means of rubber tubing to the lower end of a vertical glass tube. The strength of the air-current is regulated by means of a valve, which is so adjusted that, on blowing air through a quantity of seed contained in the glass tube, only the dirt, chaff and light seed are ejected.

The study of the advantages accruing from the use of heavy seed has now been extended to cotton, and an account of the results of work in this direction has been given recently by Dr. Herbert J. Webber and Mr. E. B. Boykin (*Farmers' Bulletin*, No. 285, *United States Department of Agriculture*, 1907).

The methods of separating the heavy seed which have just been mentioned are not applicable to American Upland cottons owing to the dense fuzz or down on the surface of the seeds which causes them to cling together. An ingenious and satisfactory method has now been devised, however, and has been used with very successful results in the experiments under consideration. In order to prevent the seeds from adhering together, the fuzz must be pasted down in some way. In the preliminary experiments it was found that this could be effected by rolling the seeds with water and some powdered substance, such as ashes, acid phosphate, or fine dry earth. Later, however, it was found more satisfactory to use paste made by mixing evenly 4½ to 5 oz. of flour with a pint of water, then adding a quart of water, and boiling until the liquid thickened. The paste is applied in the following manner. One bushel of cotton seed is placed in the rolling apparatus, which consists of a hexagonal

wooden box with an axle running through it, the latter being supported at the two ends, and furnished at one end with a crank for rotating the box. The paste is poured over the seed in the box, which is then closed and rotated for from 7 to 10 minutes. The seed is afterwards removed from the rolling apparatus and spread out to dry. The seeds do not stick together as would be expected, but remain quite distinct, each one being coated with a pellicle, which cements the fuzz closely to the surface and thus allows the seeds to separate freely from one another. This method of treating the seed is not only useful for enabling a separation to be made of the heavy from the light seed, but also facilitates sowing, as a uniform number of seeds can be readily dropped at regular distances, and thus obviates the necessity for thinning out the young plants.

For separating the heavy seed, a special form of air-blast fanning mill is recommended. The seeds prepared in the manner described are fed from a hopper on to a vibrating screen, which catches large wads of cotton or foreign substances and discharges them, but allows the cotton seed to pass through its meshes to another vibrating screen with fine meshes. From this latter screen the seeds are delivered into a short flue, where they meet a current of air driven by a fan from below, which forces the light seeds out through the top of the flue, but allows the heavy ones to drop into a box below. The separation, thus effected, does not altogether correspond with the actual weight or size of the seed, but depends to some extent on its specific gravity, but this is probably an advantage, as the seeds of high specific gravity are obviously more desirable than large seeds, which have imperfectly-developed or withered kernels.

Some experiments have been made with cotton seeds which were separated into heavy, medium, light, and very light grades. A much larger proportion of the heavy seeds germinated than of the light seeds, but the latter germinated more quickly. The plants from the light seed appeared weak and unhealthy, whilst those from the heavy seed were strong and vigorous.

A trial was made on about two acres of land in South Carolina in which heavy seeds and unseparated seeds of the same variety were planted in alternate rows. The heavy seed yielded a crop of 1,047½ lb., and the unseparated seed a crop of 944½ lb.

In another trial one acre was planted with heavy seed and another with unseparated seed; a yield of 1,164½ lb. was obtained from the former, and 1,075½ lb. from the latter. Both these tests were carried out under ordinary field conditions, and showed that the crop is increased by about 10 per cent. by the use of heavy seed.

The evidence so far obtained has shown that this simple method of separating the heavy seed for sowing is not only likely to increase directly the profits of the cotton farmer, but will probably also be found to check deterioration and effect a general improvement in the varieties grown.

CEYLON PEARL FISHERY.

AN account of the investigations carried out by Professor Herdman, F.R.S., upon the nature of the pearl banks of Ceylon and the life-history of the pearl oyster was given in the *Bulletin of the Imperial Institute*, 1905, **3.** 125. One of the results of these inquiries was the establishment of a Marine Biological Laboratory at Galle for the purpose of continuing the researches.

In Part I of the first volume of Reports from the Laboratory is an account of "The biological results of the Ceylon pearl fishery of 1904," and in Part II of the same volume a "Report on the operations of the pearl banks during the fishery of 1905." Both papers are by Mr. James Hornell, F.L.S., Marine Biologist to the Ceylon Government and Inspector of Pearl Banks, and from these sources the following notes of general interest are taken.

The oysters fished in 1904 were first seen in March 1900, when they were from three to nine months old, and in numbers too great to be estimated. They covered an area of about 5,800 acres. By February 1904 an immense decrease had taken place, the number present being estimated at 35,000,000, spread over an area of 1,122 acres. This decrease appears to have been brought about through overcrowding and sand disturbance, two of the principal causes of destruction, aided by attacks of the usual enemies of the pearl oyster, namely,

starfish, boring sponges, molluscs, and the smaller oyster-eating fishes (*Balistes* sp.).

Sand disturbance effected most harm in the South-West Cheval, where there is little rock surface to which the oysters can attach themselves, and "cultch" is not sufficiently abundant.

The overcrowding was caused by a deposit of spat in July and December 1901, which fell upon the older oysters and lived at their expense. The fall of an abundance of spat upon a bed of oysters approaching maturity is one of the greatest dangers which beset this industry, and one of the most difficult to combat.

Some observations made as to the rate of growth of oysters lend support to the belief expressed by Professor Herdman that the shell growth is most vigorous during the first two years of its life, and up to the size of about 60 mm. by 55 mm. by 24 mm., and that afterwards it slackens to a very slow rate.

There are two principal spawning seasons, which centre round January and July, times when the monsoon winds are blowing steadily and strongly. Previous to the present researches the earliest age observed at which the pearl oyster became sexually mature was six months, but individuals of not more than three and a half months have now been discovered to be sexually mature. This fact is of great practical importance with reference to the replenishment of exhausted beds by transplanting.

The spat of *Avicula vexillum*, a small bivalve related to the pearl oyster, was found in abundance. This is known as "false spat," and has, in former times, given rise to false hopes of future fisheries owing to the resemblance it bears to the spat of the true pearl oyster.

The results of an inquiry as to the yield and character of pearls from different banks showed that the oysters from the South-West Cheval were the heaviest, those from the North-West and Mid-West following next in the order named.

In regard to quality, the North-West, though yielding less in weight, contained a greater proportion of "cyst pearls," the greater weight of the South-West being due to the abundance of "muscle pearls."

The problems as to the relative abundance of the pearl-producing cestode and the causes which conduce to its death during encystment within the tissues of the oyster are still

obscure. Dissections showed that the cestode was much more abundant in oysters from the North-West than in those from either the Mid-West or South-West sections. The quantity of "muscle pearls" seems to depend on the vigour of the oyster; the more vigorous the oyster the more abundant are the muscle pearls.

It was formerly supposed that "shell pearls" resulted from an irritation to the shell caused by boring sponges, or annelids; but the results of an examination of some 30,000 pairs of separated valves negatived this supposition, and showed that these animals have little influence in pearl-production. Fully 90 per cent. of the shell pearls are due to the attachment of cyst pearls or muscle pearls to the nacreous lining of the shell. The pearls originating in this manner are at first stalked, and at this stage can be readily detached; at a later stage the peduncle, or stalk, disappears, and eventually the pearl may be entirely lost in the substance of the nacre. Shell pearls having cestode embryos as nuclei are usually irregularly disposed on the surface of the shell lining, but small attached pearls sometimes occur in regular positions coinciding with muscle scars. Decalcification of the last-named pearls revealed no organic nuclei.

At the pearl fishery which commenced on February 20, 1905, the estimated number of fishable oysters totalled over 86,200,000; the number actually fished was 81,876,520, by far the greatest number removed in any one recorded year. A record day's catch aggregated the enormous total of 4,570,460 oysters.

The South Cheval and the North and South Moderagam yielded more than all the other banks.

The chief requirement necessary to give permanent prosperity to the industry appears to be extensive transplantation of spat from unfavourable situations to areas suitable to the well-being of the oysters. It is also recommended that extensive cultching be carried on concurrently with the transplanting and the dredging of foul or overcrowded beds.

The pearl industry is represented in the Ceylon Court of the Imperial Institute by an interesting collection of specimens and photographs. The exhibit includes a series of specimens of pearl oysters ranging from four weeks to six and a half years of

age, also dissections showing pearls *in situ*. The principal enemies of the oyster are also shown, as well as a collection of instruments used by the divers and pearl merchants.

PHOSPHATE DEPOSITS OF ALGERIA AND TUNIS.

THE rapidly increasing production of rock phosphates in Algeria and Tunis, and the apparently inexhaustible nature of the deposits in these countries, give them sufficient importance to make a description of their occurrence of general interest and of special interest to Egypt, where the formations are similar and phosphate beds may be expected to occur under similar conditions, although up to the present time, on the eastern side of the Nile, they have only been proved to occur in the Cretaceous rocks.

The phosphate deposits of North Africa are generally found at the junction between the Chalk and Tertiary systems, but those in the Chalk are nowhere worth working. Rock phosphate is also found in the Jurassic system in association with calamine, but the occurrences are isolated and are without economic importance. It is also found in the younger Tertiary series, principally the Miocene, and the first mining operations were begun in these deposits, but were abandoned owing to the expense of working and the restricted area of the deposits, notwithstanding their nearness to the coast.

The principal mines are at Tebessa in Algeria and Gassa in Tunis, and in these localities the phosphate rock is found in the Lower Eocene series just above the Danian section of the chalk.

The numerous occurrences and mines of importance recorded make a full description impossible in the present article, and for further details reference should be made to a full paper on this subject by Dr. O. Tietze in the *Zeitschrift für praktische Geologie* (1907, **15**. 229).

ALGERIA.

Department of Oran. The principal occurrences are at Oran, Rio Salado, Inkermann, in the valley of Chéliff, and the Dhara

Mountain east of Mostaganem. The phosphate rock occurs in pockets, which are covered with an outer crust of breccia containing bones of recent mammals. It varies in colour from white to nearly black, and assumes concretionary forms or is compact and associated with aragonite. The best deposits contain from 60 to 82 per cent. of tricalcic phosphate.

Department of Algiers. This province contains no deposits of economic importance, though south of Boghari there are extensive formations of Eocene age containing beds of rock phosphate in which the tricalcic phosphate amounts to from 20 to 45 per cent. Those at Dra-El-Abiod are estimated to contain from 12,000,000 to 14,000,000 cubic metres of phosphatic material of this quality.

Department of Constantine. In this Department phosphate rock has a wide distribution, and mines have been opened in three districts, Bordsch-Bu-Arreridsch and Setif, El-Gerrah and Ain-Beida, and Suk-Arras and Gelma, the last containing the important workings near Tebessa, and the description of these will suffice to show the character of the strata and beds of rock phosphate.

The plateau of Dyr is of elongated elliptical shape, the longer axis of which stretches from NE. to SW., its perimeter being about 50 kilometres long. Its greatest elevation is 1,017 metres. The geological sequence shows about 100 metres of chalk of Cenomanian age, forming the base of the series, which is overlaid by 55 metres of marls and dolomitic limestone of Turonian age, and from 300 to 400 metres of marls, limestones and clays belonging to the Senonian series. It is just above the upper marls of the latter series and below the horizon of the Nummulitic limestone that the rock phosphate is found. The phosphate bed is about 3 metres thick. The upper part to a depth of 0·7 metre is rather poor and contains only about 52 per cent. of tricalcic phosphate, the average for the whole bed being 55 to 69 per cent.

The deposits at Kuif lie to the east of Dyr, and are 27 kilometres from Tebessa by the railway. The formations are exactly similar to those of Dyr, each consisting of an outlier of the denuded Eocene rocks. There are, however, three beds of rock phosphate, of which two are worked. They are thick, and can

be traced for a distance of 18 kilometres. The material of this deposit contains on the average 58 to 65 per cent. of tricalcic phosphate, while the richer portions contain up to 72 per cent. It is calculated that 6,000,000 tons of this material are available.

TUNIS.

Rock phosphate is worked in three districts in Tunis. In the vicinity of Zaghuan, the mineral is found in the Jurassic and Lower Cretaceous series, and has been worked to some extent together with calamine. The percentage of tricalcic phosphate is generally high, varying from 56 to 80 per cent. Of greater importance are the deposits occurring in Suessonian series (Lower Eocene) in the district of Béja. Instead of in chalk and marls, the phosphate occurs here in reddish argillaceous sandstone underlying limestone containing corals, which is overlaid by Nummulitic limestone. Four beds occur from 2 to 3 feet in thickness, but they are generally of poor quality. In the central part of Tunis the deposits are numerous, but probably the most important are those at Kalaat-Es-Snam and Sra-Uertan. At the former place there exist six beds of phosphate, varying in thickness from 1 to 5 feet and containing 30 to 60 per cent. of tricalcic phosphate. At the latter place the beds number about twenty-five and are from 1 to 9 feet in thickness, the percentage varying from 17 to 57. In the southern part of Tunis, in the district of Gassa, there is an important deposit near Meltaui occurring in similar geological formations to those already mentioned. The principal bed, namely, the uppermost one of the four, is 3·2 metres thick and contains from 59·5 to 61·5 per cent. of tricalcic phosphate.

It is estimated that the deposits of Meltaui contain 5,000,000 tons, and those of the whole district of Redeyeff 12,000,000 tons, with an average content of 64·5 per cent. of tricalcic phosphate.

The total exports of rock phosphate from Algeria and Tunis amounted in 1906 to 1,049,865 metric tons (of 2,204 lb.), of which Tunis was responsible for 747,303 tons.

GENERAL NOTES.

Cocoa from British Honduras.—This sample of cocoa from British Honduras was received at the Imperial Institute from the Colonial Office in 1907.

The sample weighed 30 lb. and consisted of fairly large, plump, well-fermented beans, which possessed a good "break" and were free from mouldiness. Its taste was mild and not excessively bitter.

The cocoa was similar in quality to the best grades of Trinidad cocoa which reach the English market, and a firm of brokers to whom it was submitted stated that it would meet with a ready sale in this country. It was valued in London at from 110*s*. to 111*s*. per cwt. in bags, subject to the usual conditions, at a time when the finer grades of Trinidad cocoa were quoted at 110*s*. to 112*s*. per cwt.

Sunflower Seed and Oil.—In a recent number of the *Cape Agricultural Journal* (1908, **25**. 85) attention is directed to the results of a number of experiments which have been made recently in that colony in the cultivation of the sunflower for the sake of the useful oil-seed that it yields. Seed was procured and distributed to farmers by the Cape Agricultural Department, and out of 26 reports received, 23 indicated that the plant did well, and in some cases a yield of as much as 3,250 lb. of seed per acre was obtained. It is now proposed to undertake the cultivation on a commercial scale.

The sunflower has been grown largely in Russia for the production of seed, which is used, either raw or roasted, almost as a staple article of diet. The oil expressed from the seed is prized in Russia as an edible oil. It can also be used for illuminating purposes, wool-dressing, and especially for soap-making.

The oil-cake left after the expression of the oil is rich in nitrogenous matter, and is said to have a food value similar to that of linseed or maize oil-cake.

The branches and stalks of the sunflower can also be converted into ensilage for feeding cattle.

The plant is readily grown from seed, and does best on light, well-drained and well-tilled soil. The seeds are best planted, at the rate of 10 to 15 lb. per acre, by drills, in rows about 3 feet apart and at a depth of 2 to 3 inches from the surface, the best time being the early spring. The plants take from 3 to 4 months to mature. The heads should be harvested by means of sickles before they are thoroughly ripe, and after cutting should be well dried to prevent the formation of mould. The seeds can then be thrashed out with flails, or they may be removed by means of revolving cylinders studded with nails. The yield of seed per acre is usually from 900 to 1,500 lb., and the quantity of oil obtained is from 15 to 20 per cent. of the weight of the seeds.

Mauritius Hemp from Uganda.—Two samples of Mauritius hemp were recently forwarded to the Imperial Institute by the Botanical and Scientific Department, Entebbe, Uganda. One of these had been prepared by hand, and the other by machinery.

The sample which had been prepared by hand consisted of buff-coloured fibre of fair lustre, but had not been very well cleaned, a certain amount of gummy and pulpy matter still adhering to it. The fibre was about 3 feet long and rather weak, but on the whole of fair quality. The deficiency in strength was probably due to insufficient washing during preparation, the fibre having been weakened by the plant juices which had been allowed to dry in contact with it. The product was valued at £25–£25 10*s.* per ton, when Mauritius hemp was quoted in the London market at £25–£30 per ton.

The sample which had been prepared by machinery was inferior to the preceding sample in colour and lustre. The strength was uneven and the length irregular, a good deal of short fibre being present. The material was regarded as probably worth about £15–£20 per ton.

"Kafumba" Fibre from Uganda.—In a previous number of this *Bulletin* (1905, **3**. 316–318) an account was given of the characters, composition and possible utilisation of the fibre of *Asclepias semilunata* ("Kafumba") from Uganda.

A larger sample has recently been received from the Botanical and Scientific Department, Entebbe, and has been examined with the following results.

The fibre varied in colour from white to pale brown, and was of good lustre and excellent strength. On the whole it was well cleaned and prepared, but some portions were rather gummy and dirty. The greater part of the sample was 3–4 feet long, but some was 5 feet, whilst a small quantity was less than 3 feet in length.

On chemical examination it gave constants which are recorded below in comparison with those of the earlier sample.

	Present sample. *Per cent.*	Previous sample. *Per cent.*
Moisture	9·9	7·7
Ash	2·1	3·2
α-Hydrolysis (loss)	10·0	12·9
β-Hydrolysis (loss)	16·5	19·2
Acid purification (loss)	5·3	6·2
Cellulose	88·1	80·4
Nitration (gain)	49·7	46·9

These results show that the fibre is of excellent quality and superior to the sample previously examined. The percentage of cellulose is very high. The somewhat large loss on acid purification indicates the

presence of gummy matter, which could no doubt be removed in the course of preparation. The value of the material would also be increased if it could be prepared free from the short fibre which is mixed with it. It could be used in the manufacture of rope and twine. The fibre was regarded by commercial experts as worth from £28–£33 per ton and readily saleable in large quantities, say 50 to 100 tons at a time.

Wattle Cultivation in German East Africa.—In a note in *Der Pflanzer* (1907, **3.** 252) it is stated that several samples of the bark of *Acacia decurrens*, grown at West Usambara, have been examined and reported on with a view to ascertaining whether the cultivation of wattle can be successfully undertaken in German East Africa. Many of the barks first examined gave promising results, and as a consequence a number of plantations have been laid down, principally in the neighbourhood of West Usambara. Some of the samples of bark collected recently from these plantations have proved to be of poor quality, and though barks of better quality have also been obtained, this inequality in material produced will, unless it can be remedied, seriously affect the future of the plantations. It is suggested that the difference in the tannin-content of the various samples is due to two principal causes, viz. variation in the tannin-content of the tree at different times of the year, and differences in the method of treatment (drying, &c.) of the bark after stripping. These important questions are receiving close attention with a view to the production of a wattle-bark of uniform quality.

Coca Leaves from Perak.—A sample of coca leaves was forwarded for examination to the Imperial Institute by the Director of Museums, Federated Malay States, in April of last year. It consisted of about ½ lb. of brownish-green leaves, which varied in length from 1 to 2 inches; they were brittle and very much broken. The leaves resembled those of *Erythroxylon Coca*, Lam., var. *spruceanum*, as cultivated in Java, but were rather browner than a good sample of the latter. An examination of the leaves gave the following results:—

	Per cent.
Moisture at 100°C.	9·19
Ash	6·95
Total alkaloid	0·64

The percentage of alkaloids present is quite equal to the average amount found in commercial coca from other sources.

A sample of the leaves was submitted for valuation to a firm of manufacturing chemists, who reported that the colour was not particularly good, and that at present (July 1907) similar leaves containing 0·6 per cent. of total alkaloids would fetch 7½*d.* to 8*d.* per lb. on the London market.

The firm stated that they had recently made a considerable purchase

of Java leaves of the same alkaloidal strength, but of superior colour, at the above-mentioned price.

Senna Leaves from the Sudan.—This sample of senna from the Berber Province, Sudan, was forwarded to the Imperial Institute for commercial valuation.

The specimen weighed 14 oz. and consisted mainly of the characteristic leaves of *Cassia acutifolia*, which had been carefully and rapidly dried so as to preserve their bright-green colour. The sample contained a large proportion of stalks, and in addition a few pods of *C. acutifolia*; some grass stems and a fair proportion of black shrivelled leaves, not derived from *C. acutifolia*, were also present.

"Alexandrian" and "Tinnevelly" sennas, the names by which Egyptian and Indian sennas are respectively known in commerce, are equally valuable in medicine, and the lower price obtained for commercial consignments of the former is due entirely to the presence of the stalks and foreign material which are usually mixed with the leaves.

A portion of the present sample was forwarded to commercial experts, who stated that such senna would be of very considerable value if properly collected for the market. The colour, the character by which senna is judged on the market, was described as very fine, and the present value of such leaves, freed from the stalks, was stated to be from $7\frac{1}{2}$*d.* to 8*d.* per lb.

It should also be remembered that the senna pods have a commercial value, the finest Alexandrian senna pods having realised as much as 9*d.* per lb. during the past year.

Hippopotamus Teeth from the Sudan.—A case containing hippopotamus teeth from the Sudan was received at the Imperial Institute early last year for valuation.

The specimens consisted of twelve teeth, which were of three types :—

(1) Curved and flattened, about 3 inches wide and 12 inches long, weighing about 2 lb. 13 oz. each.

(2) Straight and round, about 13 inches long, and 2 inches in diameter at the broadest part, tapering to 1 inch; average weight 1 lb. 12 oz. each.

(3) Short, round teeth, similar in shape to No. 2, but 10 inches long, $1\frac{1}{4}$ inch in diameter at the broadest portion and tapering to a point; average weight 13 oz. each.

With the exception of slight external discoloration, the teeth were all sound and in good condition. One or two of the larger specimens were rather badly split, this being probably due to carelessness in extracting them.

The teeth have been submitted to brokers, who valued them at about 1*s.* 6*d.* per lb. in the London market.

Specimens of these teeth can be seen in the Sudan Court of the Imperial Institute.

Use of Dried Cow-dung as Fuel in India.—The common practice among the natives of India of using air-dried cow-dung as fuel has frequently been condemned on the ground of the loss of the nitrogenous constituents, which are of value as manure, and samples of this material have been sent to the Imperial Institute recently for examination with a view to ascertaining whether or not the calorific value of this material is high enough to warrant its use in this way now that coal is becoming relatively cheap in many parts of India.

The sample consisted of flat cakes of air-dried material, containing fragments of dry fibrous vegetable matter and a considerable proportion of soil.

The examination of the sample gave the following results :—

Calorific value		2,045 calories*
		Per cent.
Phosphoric anhydride	P_2O_5	0·46
Lime	CaO	4·88
Magnesia	MgO	0·94
Potash	K_2O	1·60
Soda	Na_2O	0·68
Nitrogen	N	0·04
Ash		52·96

The calorific value of the dry cow-dung is therefore about one-third of that of Indian coal, which generally ranges from 6,000 to 7,000 calories.

The manurial value of the cow-dung in the condition in which this sample was received is very small, and the only constituents of manurial value lost by its combustion are the small amount of nitrogen and the organic matter, since the phosphoric acid potash and lime become concentrated in the ash left after burning.

No information was supplied regarding the methods employed in preparing the dung for fuel, but apparently most of the manurial constituents have been removed either before collection or during the process of preparation. Presumably the dung is not collected for fuel until it has become dry and combustible, by which time the bulk of the soluble manurial matter has probably passed into the soil.

It is obvious from the above results that if the sample submitted for examination is generally typical of the dried cow-dung used as fuel, the utilisation of the material in this way entails very little loss of manurial matter, and is probably the most economical method of disposing of it. The ash might be employed as a manure.

* 1 calorie is the amount of heat required to raise the temperature of one gram of water from 0° to 1° C., so that one gram of this material when thoroughly burned will raise the temperature of 2,045 grams of water from 0° to 1° C.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

NOTES SUR LE LAOS. By L. de Reinach. Pp. 123. (Paris: Vuibert et Nony, 1906.)

Laos, the largest of the five countries which together form French Indo-China, is approximately two-fifths the size of France. It comprises the inland tract, roughly resembling Italy in shape, bordered by Tongking and Annan on the east, Cochin China on the south, Cambodia, Siam, and British Upper Burma on the west, and China on the north. Between the British and French territories, as also between Siam and Laos, the river Mekong is the boundary. The Mekong, the great river of the Malay Peninsula, not only serves as one of the boundaries of the Colony, but is also the most important single factor in determining the present condition and the future prospects of the country.

Rice, the principal crop and the staple food, is cultivated on land irrigated by the river, which also supplies fish, another important article in the local dietary. The annual inundations of the Mekong leave behind the alluvial soil on which the crops of cotton, tobacco and indigo are raised. Finally, the river is the principal artery of communication with the outer world, other than Siam, for although Laos approaches fairly close to the sea on the east, the mountain masses which intervene between it and the adjoining French colonies of Annan and Tongking form an almost impassable barrier.

In addition to the principal crops already mentioned, the scanty population cultivate the sugar-cane, ramie, areca nut, cardamoms, tea, sweet potatoes, ground nuts, the coco-nut, and a few other economic plants. There are also valuable forest products, such as gum benzoin, lac, wild cinnamon, rattans, rubber, and resins.

The author gives a brief but interesting description of each of these, and suggests that of some the cultivation should be extended and that other economic plants would be worth introduction. At the same time he does not lose sight of the fact that the Laotian is not enterprising, and is content to grow merely the rice and the few other necessaries of his simple life.

The physical features of the country, as already noticed, isolate Laos, and during recent years export trade has developed more rapidly from Bangkok, *i. e.* by way of Siam, than from the ports of French Indo-China.

The volume deals with many other matters of general interest concerning Laos, and is of distinct value in summarising information about a part of the world comparatively but little known.

THE CHEMISTRY AND PHYSICS OF DYEING. By W. P. Dreaper, F.I.C., F.C.S. Pp. viii. + 315. (London: J. & A. Churchill, 1906.)

As its title implies, this work endeavours to present a survey of dyeing and all the allied processes, viewed from a strictly physical and chemical standpoint. The book is written for students, and the author has collected and attempted to correlate, as far as this is possible, all the observed phenomena in this sphere of work.

After a general introduction dealing with the properties of the chief industrial fibres and a chapter on dyes and lakes, the author gives a full description of the action of mordants, and draws particular attention to the chemical action which seems to go on between the mordant and the fibre. A detailed account is also given of the preparation of the fibre for the dye bath and the action of "assistants" in this connection, as in the absorption of acids by the fibre and the influences exerted by alkalis and neutral salts. A chapter is devoted to giving an account of colloids and the properties of colloidal solutions.

The three principal chapters in the book are those which discuss the evidence for physical and chemical action in the actual dyeing processes. The various theories and the experimental data on which they are based are set forth in great detail, and this portion of the book would be more useful if the arguments were recapitulated briefly or summarised at the end. No definite conclusions can be arrived at, at present, regarding the nature of the dyeing process, as most of the work done on the subject so far has been of a qualitative and empirical character, and there is still room for much useful work in this field.

After a chapter on the part played by colloids in the processes of dyeing and in the formation of lakes, the book is brought to a conclusion with an account of the action of light on the same processes and a useful *résumé* of the methods adopted in research work on the subject, which should prove of great value to students and to chemists proposing to embark on such investigations.

LEATHER DRESSING, INCLUDING DYEING, STAINING, AND FINISHING. By M. C. Lamb, F.C.S. Pp. xvi. + 438. (London: The Leather Trades Publishing Co.)

This treatise is a welcome addition to the small number of technical text-books dealing with the industries connected with leather production. Its scope is as comprehensive as the title implies, and the author most painstakingly describes and explains in detail the machinery, methods and meaning of the numerous processes involved in leather dressing, yet in such a manner that it should commend itself equally to the skilled workman, manufacturer, or investigator.

After a general introduction and account of the preliminary processes for the preparation of the leather, such as splitting and shaving, scouring and bleaching, the author passes to the section on dyeing. The coal-tar dyes are discussed in detail, and special attention is given to the most economical methods of furnishing the dye bath.

An elementary account of the theory of light and complementary colours leads up to an excellent description of the matching of shades.

The chapter on "Water" seems hardly so necessary, as every technical treatise now-a-days seems to feel it incumbent to devote a section to water softening, &c., the result being that it is met with everywhere.

The book provides a full account of the various processes of "finishing" with fat liquors, &c., and closes with chapters on mechanical finishing, such as printing and graining. An interesting section is provided by a chapter on novelties and fancy articles, such as "marbles" and "bronzes."

The treatise is well printed and illustrated, and is provided with numerous excellent samples of leather, illustrating the effects obtainable with the various dyes described.

IRON: ITS SOURCES, PROPERTIES, AND MANUFACTURE. By W. Greenwood, M.I.M.E., A.R.S.M., revised and partly re-written by A. Humboldt Sexton, F.I.C. Pp. viii. + 255, with numerous engravings and diagrams. (London: Cassell & Co., Ltd., 1907.)

This volume belongs to a series of "technical instruction manuals." The preface, which is by Mr. P. N. Hasluck, the editor of the series, whose name alone appears on the back of the volume, states that the manual is based on that written by the late Mr. W. H. Greenwood, which, for the present edition, has been brought up to date by Professor A. Humboldt Sexton, of the Glasgow and South-Western Technical College.

A number of desirable changes have been introduced during this revision, and, in spite of the smallness of the volume, a satisfactory account of recent advances in the metallurgy of iron is given. Particularly good features of the book are the descriptions of iron ores, and their methods of preparation for smelting.

The book is well illustrated with reproductions from photographs of many types of machinery of recent introduction into metallurgical industry.

PRACTICAL COAL-MINING. By Leading Experts in Mining and Engineering, under the Editorship of W. S. Boulton, B.Sc., F.G.S. Divisional-Volume 4. Pp. vi. + 212, together with six plates and numerous diagrams. (London: The Gresham Publishing Company, 1907.)

Previous volumes of this work have been reviewed already in this *Bulletin* (1907, **5**. 197, 316, and 449).

The present volume contains a continuation of the article on pumping by Mr. W. E. Lishman. It is a readable account of the numerous forms of mechanism that are employed. Some minor criticisms may, however, be made. Successive lifts of turbine pumps are employed not only in Spain, but in South Wales and Cornwall. High speed ("express") pumps should have been mentioned, for they bid fair to be widely employed in the immediate future. The diagram on p. 245 is calculated to puzzle the intelligent reader, who will ask what becomes

of the water from the hydraulic pump at B, and if there be a channel by which it can escape, why the water from A cannot be got rid of in the same way. The section concludes with a chapter on dams.

To Mr. H. W. G. Halbaum is allotted the subject of ventilation, so much more important in coal than in metalliferous mining. He takes nothing for granted, but commences with the first principles of the constitution and kinematics of gases. The explanations are somewhat condensed, but the reader who gives the close attention necessary to follow the development of the theory will have a good grasp of the subject. The Rateau fan, which is now being widely adopted in Germany, should have been referred to.

The last section in the present volume on the transmission of power is also by Mr. Lishman, and appears to contain a comprehensive survey of the subject.

CLAYS: THEIR OCCURRENCE, PROPERTIES, AND USES; WITH ESPECIAL REFERENCE TO THOSE OF THE UNITED STATES. By Henrich Ries, Ph.D. Pp. xvi. + 490, with numerous photographs and diagrams. (New York: Wiley & Sons. London: Chapman & Hall, Ltd., 1906.)

The plastic minerals, commonly known as clays, present a most interesting series of problems both to the geologist and the chemist. They have been applied empirically from the earliest times to the fabrication of a great range of industrial products, and it is only in recent years that the numerous industries dependent upon clay as a raw material have begun to make use of the results of scientific investigation, and even to encourage such investigation in special laboratories devoted to the study of ceramic arts.

The volume now under notice gives a readable and succinct account of the methods by which clays originate by the decomposition of rock materials, and the changes they subsequently undergo due to the action of geological forces.

Different authorities have classified the clays in a great variety of ways, and these are briefly referred to and some account is given of the various minerals contained in them. This is followed by a chapter which discusses their chemical composition, methods of analysis, and the important changes which take place when clays are fired.

The most important property exhibited by clays is their plasticity, which permits of their being worked into almost any desired shape when moist. The causes of this plasticity are discussed in detail in Chap. III.

In succeeding chapters the mining, preparation and working of clays are described, and the last three are devoted to detailing the distribution of "china," "fire," "pottery," and "brick" clays in the United States. A special short chapter at the end is reserved for the consideration of the related product, "fullers earth."

The book will be equally useful to those engaged in prospecting and to those concerned with the industrial utilisation of the various kinds of

clay. The illustrations are numerous and good, and misprints are rare. Page 277 is, however, headed "Chap. VI." instead of "Chap. V."

NEW JERSEY GEOLOGICAL SURVEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR THE YEAR 1905. Pp. ix. + 338, together with several maps and illustrations. (Trenton, N. J.: MacCrellish & Quigley, State Printers, 1906.)

This report comprises a number of articles by members of the Survey, embodying the results of its operations. They are mainly of economic interest, and include a great deal of information of interest beyond the limits of the State.

Considerable attention has been given to the changes resulting from marine action on the coast, and the methods available for controlling them. Another article deals with the analysis of the ancient white crystalline limestone of certain parts of the State with especial reference to the content of magnesia, which diminishes its value for use in the preparation of Portland cement and in blast furnaces. It is shown that neither the neighbourhood of igneous intrusions nor the colour or physical characters have any close relation to the percentage of magnesia.

The distribution, preparation and utilisation of peat are also described at some length.

GEOLOGICAL MAP OF ARMENIA WITH EXPLANATORY NOTES. By Felix Oswald, B.Sc., B.A., F.G.S. Pp. 16. (London, 1907.)

This map, which is on a scale of 16 miles to the inch, embraces the work of the author and other observers on the geology of this important region. The notes give a brief account of the geology and physical geography of the country, and the reader is referred for further information to the book on the Geology of Armenia by the same author.

INVENTIONS, PATENTS AND DESIGNS, WITH NOTES AND THE FULL TEXT OF THE NEW BRITISH PATENTS AND DESIGNS ACT, 1907. By G. Croydon Marks, M.P. Pp. 116. (London, no date.)

The author, who is a well-known patent agent, has written a useful little book for inventors. In the introduction he criticises the want of enterprise and stereotyped methods of British manufacturers. In the ensuing pages he describes the origin of the "patent law" in the Statute of Monopolies, the interpretation placed upon the latter, and the provisions of modern legislation, especially with regard to the procedure for obtaining and defending patent rights. At the same time he gives some general advice to patentees on the best methods of reaping the benefits of their inventions. After a concluding chapter on the registration o designs, the Patents and Designs Act of 1907, which repeals all previous Acts, except, of course, the Statute of Monopolies itself, is printed in full with the alterations in the law distinguished by italics.

COLONIAL PUBLICATIONS.

Copies of the following publications, descriptive of the resources of British Colonies and Dependencies, have been received recently. They are available for distribution at the Central Stand in the Exhibition Galleries, free of charge so long as numbers permit.

HANDBOOK OF THE AUSTRALIAN STATES. Pp. 94, with 8 maps. (London, 1907.) This handbook, written as a guide for emigrants, affords a concise account of the physical features, general conditions, chief products and leading industries of the Australian States, including Tasmania, and New Guinea or Papua. Practical information, of the nature required by emigrants, is given, and throughout stress is laid on the advantages offered by Australia to the British settler. To others the book serves as a very useful summary of the existing economic conditions in this portion of the British Empire.

VICTORIAN YEARBOOK, 1906–7. Part X. (PRODUCTION.) By E. T. Drake, Government Statistician. Pp. 469–658. (Government Printer, Melbourne.) This separate portion of the annual *Yearbook* affords a comprehensive and authoritative summary of the products and resources of the State. In addition to the subjects indicated by the title, full accounts are given of such matters as land settlement, water supply and irrigation, agricultural education, wages, &c. The chief products are then dealt with group by group, and in several instances comparative information is given, *e. g.* the table showing the yield of the principal crops in Australasia from 1899–1907. The agricultural and pastoral industries are treated at considerable length with full statistics, and Mr. A. E. Kitson contributes a section on the mineral resources of the State. Comparative statistics are here given also, *e. g.* the world's production of gold and silver since 1860, and the relative contributions of the chief gold-producing countries in 1905.

THE TREND OF VICTORIA'S PROGRESS. By the Hon. Thomas Bent, Premier of Victoria. Pp. 24. (Spottiswoode & Co., Ltd., 1907.) A Reprint of a Paper read before the Royal Colonial Institute, June 11, 1907. Finance, physical features, industries, closer settlement, water conservation, social topics and education are amongst the principal matters discussed. Victoria depends for its prosperity upon its fertile soil and good climate. Mr. Bent shows how the State has comparatively recently emerged from the primitive pioneer stage, where rough and ready methods suffice, into that where success depends on the application of scientific knowledge to agriculture, as evidenced, for instance, by the comprehensive scheme for water conservation and irrigation, on which, up to the present, some £3,000,000 have been spent.

NEW ZEALAND OR AO-TEÄ-ROA (The Long Bright World). By James Cowan. Pp. 220. (Published by the New Zealand Government Department of Tourist and Health Resorts. Wellington, 1907.)

New Zealand offers many attractions to tourists and invalids, and these are well set forth in this handbook, which, with its numerous and good illustrations and maps, affords an excellent introduction to the wealth and resources, scenery, travel routes, spas, and sport of the southern Dominion. On the economic side, agriculture, horticulture, the forest resources and mineral wealth are adequately treated and fully illustrated, as, for example, by the illustrations of modern methods of gold-dredging. The chief towns and tourist resorts are described at considerable length. The work should help to induce many, who have the opportunity, to visit New Zealand, and also be of service to these and many others as a comprehensive handbook to the country.

RHODESIA. Information for Tourists and Sportsmen. Pp. 129. (Issued by the British South Africa Company, 1907.) This is a general handbook on Rhodesia, copiously illustrated and provided with five maps, amongst which may be noted those illustrating railway development, and the game districts in North-Western Rhodesia. Practical hints on routes, outfit, the chief places of interest, and information for sportsmen, including a summary of the game laws, take up the greater portion of the book.

GAME OF BRITISH COLUMBIA. Official Bulletin, No. 17, of the Bureau of Provincial Information, 2nd edition. Pp. 68. (Printed by Authority of the Legislative Assembly, Victoria.) This bulletin is intended primarily to be of service to those who visit British Columbia for purposes of sport. The principal classes of game are briefly reviewed, with useful notes as to the cost of expeditions. The game laws are given in detail and conveniently summarised in a tabular statement. The main portion of the work is occupied with a check list of the birds and mammals, prepared by Mr. F. Kermode, Curator of the Provincial Museum, in which the local and scientific names of each species are given, together with its geographical distribution. The bulletin is fully illustrated.

INDIAN AND COLONIAL COLLECTIONS.

WEST AFRICAN COURT.

SIERRA LEONE EXHIBITS.

THE Colony of Sierra Leone has a coast line of 210 miles, extending between 6°55′ and 9°2′ N. latitude from the territory of the republic of Liberia on the south to French Guinea on the other side. For the most part the Colony consists of a mere strip of land along the coast, but immediately adjoining the Colony is the Protectorate.

The area of the Colony is 4,000 square miles, and the population in 1901 was 76,655. The area of the Protectorate, which is situated between 7° and 10° N. latitude and 11° and 13° W. longitude, is about 30,000 square miles, or approximately that of Ireland, and the population in 1901 was 949,827.

The capital, Freetown, lies on a peninsula about four miles up the Sierra Leone River, at the foot of a chain of hills rising 1,700 feet above the sea. It contains, according to the census of 1901, 34,463 inhabitants, and possesses the best harbour in West Africa.

The following notes on the history, physical features and climate of Sierra Leone are in the main taken from Lucas's *Historical Geography of the British Colonies*, vol. iii.

History.—Though the history of Sierra Leone as a British Colony only dates from 1787, constant notices of the place occur in the records of earlier years. It was first sighted in 1461 or 1462 by Pedro da Cintra, and was visited by Sir John Hawkins 100 years later. Before the sixteenth century ended many other British sailors touched at Sierra Leone, among them Sir Francis Drake. From about 1660 onwards there appears always to have been a British "factory" or dépôt for stores at Sierra Leone on one or other of the little islands which lie in the estuary higher up than Sierra Leone.

The Peninsula of Sierra Leone was ceded to the United Kingdom in 1788 by native chiefs. The main purpose of the Colony in its inception was to secure a home on the African continent for natives of Africa and others who, from various circumstances, had been separated from their countries of origin and were struggling waifs in and about London. Somewhat later the Colony was much used as a settlement for natives rescued from slave ships, as well as for numbers of liberated slaves from America and the West Indies. The hinterland was declared a Protectorate in 1676.

Physical Features.—The Peninsula of Sierra Leone is about 25 miles in length, and from 10 to 12 miles in breadth at its widest part. It is one of the few points on the African coast where there is high land near

the sea. It is formed by a range of volcanic mountains, running parallel to the sea from NNW. to SSE., the summits of which, in the Sugar Loaf and Leicester Mountains, rise in conical form to a height of from 2,000 to 3,000 feet. The mountains are composed principally of granite, and are thickly wooded. They are intersected by ravines and small valleys, and there are considerable tracts of level ground, especially on the eastern side of the peninsula, where it sinks to the mainland.

The configuration of the Protectorate varies much in different localities. The parts on the banks of the rivers are low and swampy, while away from the rivers the country consists of low rolling downs, with here and there a range of hills some 3,000 feet in height. Unlike many regions on the West Coast of Africa, the country is for the most part well watered by rivers and running streams. The principal rivers which empty themselves into the Atlantic on the Sierra Leone coast are the Great and Little Scarcies, the Sierra Leone or Rockelle, the Sherboro, the Jong, and the Manneh or Mano, all of which are navigable for several miles.

Climate.—The seasons may be divided into wet and dry, the former lasting from May to October, and the latter from November to April. The rainfall averages from 150 to 160 inches per annum, and nearly all falls in the six months of the wet season, during which tornadoes and violent thunderstorms are frequent, particularly at the beginning and end of the season. The Harmattan wind, a hot dry wind from the Sahara, blows during a part of the dry season. The annual range of temperature is between 62° and 89° F.

VEGETABLE PRODUCTS.

The principal products exported from Sierra Leone are palm kernels, palm oil, benni seed (sesamé), ground nuts, kola nuts, rubber, copal, ginger and hides. Most of the vegetable products are derived from wild plants. The chief agricultural work lies in the cultivation of rice and cassava for local consumption. The kola tree is found near almost every village, and from its produce a considerable portion of the revenue of the native inhabitants is derived.

Palm Oil and Palm Kernels. Palm oil, extracted from the outer fleshy portion of the fruits of the oil palm (*Elæis guineensis*), is important locally as a food, and is also exported in large quantities.

Palm Kernels. The kernels or seeds contained in the nuts or "stones" of the oil palm are obtained by cracking, by hand or by the aid of a nut-cracking machine, the nuts after the orange-coloured palm oil has been extracted from the outer pulpy portion of the fruit. The kernels are exported, and the extraction of the oil carried out in Europe. Palm kernel oil is white in colour and of rather softer consistence than palm oil. It is largely used in the manufacture of

soaps. The best grades can be employed for the preparation of "vegetable butter," like coco nut oil.

Palm kernels and palm oil are the principal exports of Sierra Leone, together comprising about 68 per cent. of the total exports of the country.

Samples exhibited—

Palm Oil.
Palm Kernels.

Copra. The dried kernel of the coco nut palm (*Cocos nucifera*). This is an important product in many tropical countries, large quantities being imported into Europe for the preparation of coco nut oil. Up to the present but little has been done in preparing copra in Sierra Leone.

Sample exhibited—Copra.

Physic Nuts. The fruits of the cosmopolitan plant *Jatropha Curcas.* The seeds have purgative properties and are used in local medicine. Commercially they are of interest because they yield a semi-drying oil employed in the manufacture of soap and candles (see *Bulletin of the Imperial Institute*, 1904, **2**. 170).

Sample exhibited—Physic Nuts.

Kola Nuts (*Cola acuminata*). Kola trees are extensively grown in the Protectorate, in the neighbourhood of towns and villages, and the seeds or "nuts" find a ready sale at remunerative prices, both locally and in other parts of West Africa. The annual value of the kola nuts exported sometimes exceeds £100,000.

For transport, the nuts are packed in large baskets, surrounded by several layers of green leaves, and under these conditions they keep fresh for several months. Bathurst (Gambia) and Dakar (Senegal) are the largest markets for the kola nuts exported from Sierra Leone.

Sample exhibited—Kola Nuts.

Ginger. The dried underground stems of *Zingiber officinale.* Ginger is cultivated in considerable quantities and exported. Efforts have been made to improve the preparation of this product, and samples of ordinary and specially prepared ginger received at the Imperial Institute showed that the means adopted yield an improved product (see *Bulletin of the Imperial Institute*, 1907, **5**. 24). The value of the ginger exported is about £10,000 per annum.

Samples exhibited—

Dried Ginger.
,, ,, , ordinary.
,, ,, , prepared by an improved process.

Chillies and Capsicums. The fruits of species of *Capsicum*, e. g. *C. annuum* and *C. frutescens*. They are very pungent, and, when dried and ground, form cayenne pepper. Chillies are exported to a small extent.

Samples exhibited—

Chillies.
Capsicums.

Guinea Grains. The dried seeds of *Afra-Amomum Melegueta*. Also known as Grains of Paradise and Melegueta pepper. They were formerly in considerable demand in Europe as a spice, but are now mainly employed in veterinary medicine. The natives use them for their aromatic and stimulating properties.

Sample exhibited—Guinea Grains.

Coffee. There are two varieties of coffee grown in the Colony, viz. Liberian coffee (*Coffea liberica*), and that known as Sierra Leone coffee (*Coffea stenophylla*). The prices obtainable for these coffees in the European markets are not sufficiently high to encourage the export of this product, and the entire crop is used locally.

Sample exhibited—Coffee.

Cocoa. This product is grown on a small scale, and not in sufficient quantity to form an article of export.

Sample exhibited—Cocoa Beans.

Copal and Ogea Resins. The source of most of the West African copal is stated to be *Daniella thurifera*. Similar resins from Sierra Leone are believed to be derived from one or more species of *Cyanothyrsus*, at present undetermined. The exact origin is, however, doubtful, and *Guibourtia copallifera* has also been suggested as the source of the recent and fossil copals of the Colony.

The copal is used in the preparation of varnishes. In 1905 the exports of this article were valued at £3,210, and in 1906 at £3,945.

Samples exhibited—

Gum Copal.
Ogea Gum.

Gambia Pods. The pods of *Acacia arabica*. These are used, especially in India, the Sudan, and West Africa, as a tanning material. An analysis of these pods from the Sudan has been given already in this *Bulletin* (1906, **4.** 96).

Sample exhibited—Gambia pods.

Indigo. The leaves and twigs of the widely-distributed *Lonchocarpus cyanescens* are employed as a source of indigo (see *Bulletin of the Imperial Institute*, 1907, **5**. 129).

Sample exhibited—Leaves and twigs of the Gara plant.

Fruit and Leaves of the Baobab (*Andansonia digitata*). The leaves are stated to be employed by the natives as a prophylactic against fevers during the rains; also to check excessive perspiration and as an astringent. The pulp surrounding the seeds is employed in native medicine in the treatment of fevers and in dysentery. (Compare *Bulletin of the Imperial Institute*, 1906, **4**. 282.)

Samples exhibited—

Fruit of the Baobab.
Leaves of the Baobab.

Calabar Beans. The seeds of *Physostigma venenosa*. This is the ordeal poison bean of West Africa. The alkaloid *physostigmine*, prepared from them, is used in medicine, in virtue of its property of causing contraction of the pupil of the eye.

Sample exhibited—Calabar Beans.

Rubber. The rubber obtained in Sierra Leone is probably yielded by species of *Landolphia* (*L. owariensis* and *L. Heudelotii*, var. *Djenge*), &c., and *Funtumia elastica* (*Bulletin of the Imperial Institute*, 1906, **4**. 29). The annual value of the rubber exported during the years 1902 to 1905 varied from £8,192 to £49,132.

Samples exhibited—

"Manoh First" rubber.
"Manoh Second" (root) rubber.
Paste rubber.

Cotton and Cotton Goods. The cultivation of cotton by the natives is carried out on a small scale. In certain parts of the Protectorate native cloth is manufactured for local use, and only sufficient cotton is grown to meet the needs of this industry.

Samples exhibited—

Native cotton "Doole."
Native cotton "Fandewi."
Native cotton "Mixed."
Native cotton "Quondi."
Native cotton yarn (white and brown).
Roll of native cloth.
Loom.

Roll of cloth attached to loom.

Hammock cloth—a decorative cloth of native manufacture, used as awning over hammock. The wool-like centre is made of tufts of raw cotton.

Fibres. *Hibiscus quinquelobus.* This plant is known in Sierra Leone as "Kowe" or "Corwey" in the Mendi language, and "Nassim" in Timani language, and is sometimes referred to as "West African Jute."

Owing to the facility with which this fibre can be prepared, it has received special attention, and a small export trade is being developed; but a large industry will necessitate systematic cultivation of the plant.

Samples of this fibre which were examined in the Scientific and Technical Department of the Imperial Institute proved to be of good quality, and to resemble jute. Commercial experts classed the material as a strong bast-like fibre of good colour, and worth £25 to £26 per ton, June 1906 (*Bulletin of the Imperial Institute*, 1907, **5**. 5).

Sample exhibited—"Corwey" fibre.

Honckenya ficifolia. This plant is known by the various names of "Napunti" (Timani), "Potepo" (Mendi), and "Bolo-bolo" (Yoruba). It grows abundantly in the swamps of the Sierra Leone Protectorate, and would yield a perpetual supply of stalks for retting if care were taken in cutting. Considerable difficulty is experienced in separating the outer bark from the inner fibrous layer, particularly in older plants. Experiments are in progress to ascertain whether the fibre can be more successfully extracted from young plants.

A sample of this fibre, received at the Imperial Institute for examination, closely resembled Indian jute, and should prove very resistant to the prolonged action of water. The product was described by experts as a jute-like fibre of mixed colour; value about £20 per ton, June 1906 (*Bulletin of the Imperial Institute*, 1907, **5**. 6).

Sample exhibited—"Napunti" fibre.

"*Borfroko*" *or* "*Abala*" *Fibre.* The plant yielding this fibre is at present unidentified. The fibre is inferior to "Napunti" and "Corwey" fibres on account of its variation in colour, length, and texture (*Bulletin of the Imperial Institute*, 1907, **5**. 7).

Sample exhibited—"Borfroko" fibre.

Urena lobata. The plant is known in West Africa as "Na fen fe" (Timani), "Subwe" (Mendi), and "Bolo-bolo" (Yoruba). The plant occurs everywhere along the West African coast, but is extremely variable in the form of its leaves. Good specimens of the fibre have been prepared in Sierra Leone, but the plant growing there does not form long, straight stems, and the fibre is therefore rather short (*Bulletin of the Imperial Institute*, 1907, **5**. 9).

Sample exhibited—*Urena lobata* fibre.

Sansevieria guineensis. Sansevieria plants are widely distributed in the tropical regions of both hemispheres. The leaves of many of the species furnish valuable fibres, known commercially as bowstring hemps, and classed with sisal hemp. *Sansevieria guineensis* is found growing in Sierra Leone in a narrow belt along the sea shore, under the shade of trees. It also seems to thrive in places remote from the sea.

Sample exhibited—Sansevieria guineensis fibre.

Corchorus sp. yields a fibre known locally as "Crin-crin," which closely resembles jute (*Bulletin of the Imperial Institute*, 1907, **5**. 3).

Sample exhibited—"Crin-crin" fibre.

Palm Leaf Fibre. Obtained from the leaflets of the oil palm (*Elæis guineensis*). It is a fibre of great strength and excellent quality. (Compare *Kew Bulletin*, 1892, 240, and *Bulletin of the Imperial Institute*, 1903, **1**. 21).

Sample exhibited—Palm Leaf Fibre.

Pissava. A fibrous product obtained from the sheathing bases of the leaf-stalks of *Raphia vinifera*, the "Bamboo" or "Wine Palm." The material is a stiff wiry fibre, which varies in diameter from $\frac{1}{30}$ to $\frac{1}{16}$ inch, and is used in Europe for the manufacture of brooms and brushes. The fibre is extracted from the stumps of the leaf-stalks by a process of soaking, and scraping or beating.

The trade in this fibre from Sierra Leone is considerable, and the exports were valued at £5,412 in 1906.

MINERAL PRODUCTS.

Iron Ore. Considerable deposits of iron ore occur in Sierra Leone, and representative samples are shown in the Court.

Sample exhibited—Iron Ore from Mount Bathurst.

MISCELLANEOUS EXHIBITS.

Maps and Statistics. Map of Sierra Leone.
" " (showing Provinces only).
" Sierra Leone Peninsula.
" Sierra Leone Railway.
Diagram giving the General Statistics of the Colony and Protectorate.

Photographs—

Freetown, the capital of Sierra Leone.
View from Kroo Bay.
Macaley.
Westmoreland St., Freetown.
Views in Sherbro district.
Freetown, showing Harbour and Tower Hill Barracks.
Bonthe, Sherbro district.
Freetown Harbour.
Native Loom for Weaving Cotton.
Plastering Walls of Native House.
Charlotte Falls, near Freetown.
Mafulomu.
Natives attired for the Bundu Devil-dance.
Hammock Bridge of Native Construction.
Congo Town Village.
Panguma.
Seira Bridge, on the Government Railway.
General View in Freetown, from the Hills.
Freetown Harbour.
York Island, Sherbro district.
The Bum Kittam River at Garinga, Sherbro district.
The Palm Oil Industry in Sierra Leone.
An Oil Palm Forest.
Measuring and Packing Palm Kernels for Export.
Transporting Palm Kernels.
Collecting the "heads" of Palm Nuts.
Preparing Palm Oil.
Rice Cultivation in Sierra Leone.
Preparing the Ground.
Hoeing with the short-handled Native Hoe.
Gathering Rice.
Threshing Rice.
Husking Rice.

Native-made Articles—

Basket.
Leathern Case for Hammock Cloth.
Water Cooler from Panguma.
Native Lamp ,,
Armlet.
Knife.
Fishing Net.
Native Anchor.
Stone Axe-head.

LIBRARY.—RECENT ADDITIONS.

Books, &c., exclusive of Government Publications, presented to the Library of the Imperial Institute since November 24, 1907.

Rubber Share Handbook . . . . (*Messrs. J. Russell & Co.*)

The Fauna of British India, including Ceylon and Burma. Vol. iv., Part i., Rhynchota (Homoptera) . . . By W. L. Distant. (*The Under Secretary of State for India.*)

Le Livre d'Or de l'Exposition Universelle et Internationale de 1905. Histoire Complète de l'Exposition de Liège .	By Gustave Drèze. (*The President and Secretary.*)
Queensland Geographical Journal. Including the Proceedings of the Royal Geographical Society of Australasia, Queensland Branch. Vol. xxii., 1906–1907	(*The Secretary.*)
The Guide to South Africa for the Use of Tourists, Sportsmen, Invalids and Settlers. 1907–1908 edition . .	(*The Union Castle Mail Steamship Co., Ltd.*)
Notes sur le Laos	By L. de Reinach. (*The Author.*)
British Indians and the Transvaal . .	By L. W. Ritch. (*The Author.*)
Cape Colony To-day	By A. R. E. Burton, F.R.G.S. (*The Agent General for Cape Colony.*)
Transactions and Proceedings of the New Zealand Institute, 1906. Vol. xxxix. .	(*The Secretary.*)
Grenada Handbook, 1908	(*The Crown Agents for the Colonies.*)
Transactions of the Royal Society of Edinburgh. Vol. xlv., Parts ii. and iii.	(*The Secretary.*)
Documentary History of Education in Upper Canada (Ontario). Vol. xix., 1865–1867, and Vol. xxi., 1868–1869 .	By J. Geo. Hodgins, I.S.O., M.A., LL.D. (*The Minister of Education.*)
Report of the Committee of the Bengal Chamber of Commerce for the year 1906. Vol. ii., Documents and Correspondence	(*The Secretary.*)
Proceedings of the Royal Institution of Great Britain. Vol. xviii., Part ii., No. 100	(*The Secretary.*)
Review of the Frozen Meat Trade, 1907 .	(*Messrs. W. Weddel & Co.*)
Proceedings of the Anglo-Russian Literary Society, October, November, December, 1907	(*The President and Hon. Secretary.*)

A Drama of Two Lives, The Snake Witch, A Canadian Summer Night, and other poems	By Prof. E. J. Chapman, Ph.D., LL.D. (*Mrs. E. J. Chapman.*)
British Guiana and its Resources . .	By Prof. J. B. Harrison, M.A., C.M.G., F.I.C., F.C.S. (*The Author.*)
The Plenum or Propulsion System of Heating and Ventilation	By Harold Griffiths. (*The Author.*)
Subject Matter Index of Mining, Mechanical and Metallurgical Literature for the year 1902	(*The North of England Institute of Mining and Mechanical Engineers.*)
Columbia University Bulletin of Information, Eighth Series. No. 1.—Annual Reports, 1907. No. 2.—Catalogue and General Announcement, 1907–1908 .	(*The Clerk to the University.*)
The Delagoa Directory for 1908. A Yearbook of Information regarding the Port and Town of Lourenço Marques	(*Messrs. A. W. Bayly & Co.*)
The Leeds Incorporated Chamber of Commerce, Fifty-seventh Annual Report	(*The Secretary.*)
The Gibraltar Directory for 1908 . .	(*The Colonial Secretary.*)
Rubber-producing Companies, showing their History and Results	(*Messrs. Gow, Wilson & Stanton, Ltd.*)
Newspaper Press Directory for 1908 .	(*Messrs. C. Mitchell & Co.*)
University of Leeds, Fourth Report, 1906–1907	(*The Secretary.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1908. VOL. VI. NO. 2.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial Governments concerned.

THE DEVELOPMENT OF THE RESOURCES OF THE SEYCHELLES.

1. Essential oils
2. Citrate of lime
3. Banana products
4. Orchella weed
5. Kapok
6. Gutta percha and Rubber
7. Mangrove barks
8. Mother-of-Pearl shells
9. Natural Phosphate deposits
10. Laterite

IN an earlier number of this *Bulletin* (1904, **2.** 269), a short account was given of the various agricultural and planting industries carried on in these Islands, and it was then pointed out that the principal agricultural product exported was vanilla, and reference was made to the difficult situation that had been created by the fall in price of this important product, owing in part to over-production and in part to the competition of the chemically prepared odorous constituent, vanillin, which had largely replaced the vegetable product for flavouring purposes (compare this *Bulletin*, 1904, **2.** 30). Since then the attention of planters has been to some extent turned to other materials, and cocoanut products have replaced vanilla as the chief article of

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export, though the latter still occupies an important place, as is shown by the fact that out of total exports valued at 794,681 rupees in 1906, vanilla accounts for 101,818 rupees. A number of minor industries have been created, which indicate that in future the Colony will not be so largely dependent on the market for a single product as previously. In connection with the development of these secondary industries a large number of vegetable and mineral products has been received at the Imperial Institute from the Governor of the Seychelles during the last few years, and in view of the promising nature of many of these it seems worth while to give a summary of the results obtained.

I. ESSENTIAL OILS.

Lemon Grass Oil.

In all seven samples of this oil, experimentally distilled in the Seychelles, have been received for examination. They were described as follows:—

Samples received in 1906.

Nos. 1, 2, 4, 5. Seychelles Lemon grass. No. 4 is the first fraction and No. 5 the second fraction of the same distillate.

No. 3. Ceylon Lemon grass.

No. 6. Ceylon Lemon grass. This represents the second fraction of a distillate of which the first fraction was lost in transit.

Sample received in 1907.

No. 7. Lemon grass oil [probably Seychelles].

The "Seychelles lemon grass oils" are distilled from a lemon grass obtained from Mauritius in the latter half of the eighteenth century and the "Ceylon oil" from grass introduced from Ceylon in 1903. According to M. Dupont, Curator of the Botanic Station, Seychelles, the Seychelles lemon grass yields 0·23 per cent. of oil and the recently introduced Ceylon variety 0·34 per cent. (Col. Reps., Miscellaneous. No. 520. [Cd. 3285–7]).

On examination these samples gave the following results. The first three were so small that the optical rotation and solubility in alcohol could not be determined.

Number of sample.	Description.	Specific gravity at 15° C.	Optical rotation in a 10 cm. tube.	Solubility in alcohol.	Content of Citral.
					Per cent.
1	Pale yellow	0·923	—	—	60
2	,, ,,	0·903	—	—	74
3	,, ,,	0·894	—	—	71
4	Rather dark yellow	0·887	− 0° 56′	Incompletely soluble in 70 or 80 per cent. alcohol. Soluble in ½ to 1½ volumes of 90 per cent. alcohol, becoming cloudy on further dilution	73·3
5	Rather dark yellow	0·894	− 0° 4′	Incompletely soluble in 70 or 80 per cent. alcohol. Soluble in ½ to 1½ volumes of 90 per cent. alcohol, becoming cloudy on further dilution	68·5
6	Rather dark yellow	0·892	− 0° 10′	As samples 4 and 5	61·7
7	Pale yellow	0·887	+ 0° 10′	As samples 4 and 5	50·0

The first three oils were submitted in 1906 to experts for commercial valuation, and they were reported on as of very good quality and then worth 8*d.* to 8¼*d.* per ounce. The samples subsequently received, of which three were but slightly inferior to the first three in quality, were received late in 1906 at a time when lemon grass oil was practically unsaleable in this market owing to great over-production, a condition of things from which the industry has not yet recovered. Thus the present price of lemon grass oil containing 70 per cent. of citral is only 1½*d.* per ounce. Sample No. 7 is of inferior quality. It is clear from the foregoing results that lemon grass oil of good quality can be produced in the Seychelles.

Citronella Oil.

Three specimens of this oil were received for examination in 1906. They were obtained by the distillation of grass grown from stock introduced from Ceylon in 1903. The samples were as follows:—

No. 1. Ceylon Citronella. Yield of oil 0·39 per cent.
No. 2. Ceylon Citronella. } No. 2 is the first and No. 3 the
No. 3. Ceylon Citronella. } second fraction of one distillate.

On examination these gave the following results:—

Number of sample.	Specific gravity at 15° C.	Optical rotation in a 10 cm. tube.	Solubility in 80 per cent. alcohol.	Geraniol.	Citronellal.
				Per cent.	*Per cent.*
1	0·910	− 12° 49′	—	—	—
2	0·901	− 14° 1′	1 in 1	30·5	28·3
3	0·907	− 11° 41′	1 in 1	33·1	35·4

Sample No. 1 was valued by experts in 1906 at 1*s.* 7*d.* per lb. and was described as of very fair quality. Samples Nos. 2 and 3 were valued early in 1907 at 1*s.* 10*d.* to 2*s.* 0*d.* per lb., and it was suggested that it would be advantageous to mix the two fractions before sale. These results show that this Seychelles citronella oil compares favourably in composition and quality with the citronella oils on the market from other sources.

Essence de Bigarade.

Two samples of this oil were received in 1906. No. 1 was distilled from unripe fruits cut into half without removal of the pulp, and No. 2 from entire ripe fruits. The yield of No. 1 was not stated, that of No. 2 was 0·15 per cent. Sample No. 1 had specific gravity 0·856 at 15° C. and optical rotation in a 10 cm. tube + 85° 33′, whilst No. 2 had specific gravity 0·862 and optical rotation + 84° 32′ in a 10 cm. tube. The experts who examined the samples stated that No. 2 more fully conformed to the type of "Essence de Bigarade" as sold in the United Kingdom, but both were described as of fair quality and worth 7*s.* 3*d.* to 7*s.* 6*d.* per lb.

"Mozambique Orange" Oil.

A sample of this oil was also received in 1906. It was obtained by the distillation of two kilograms of rinds of the fruits, freed from pulp, and the yield amounted to 8·9 per cent. The sample had specific gravity 0·849, and optical rotation + 91° 52′ in a 10 cm. tube. The commercial experts who examined the sample pointed out that in view of the considerable difference of this oil from the sweet orange oil of commerce a large sample would be required for trial before any definite idea of its value could be obtained.

Ylang-Ylang Oil.

Of this oil two samples were received in 1906, described as follows:—

No. 1. "Ylang-ylang oil. Yield of oil from flowers 0·57 per cent." No. 2. "Ylang-ylang oil. Yield of oil from flowers 0·58 per cent." Sample No. 1 had specific gravity 0·958 and optical rotation − 45° 27′, whilst No. 2 had specific gravity 0·924 and

optical rotation $-18° 46'$. The specific gravities were taken at 15° C. and the optical rotations in 10 cm. tubes in both cases. The second sample was unusually dark in colour, and its specific gravity and rotation are below the normal. Sample No. 1 was valued by experts in 1906 at 13*s*. to 14*s*. per lb., and was described as of extremely fine quality and quite equal to any Ylang-ylang oil imported into this country. No. 2 was valued at the same time at 6*s*. 9*d*. to 7*s*. per lb.

Cananga Oil.

A sample of this perfume oil forwarded in 1906 proved on examination to have specific gravity 0·954, and optical rotation $-43° 10'$, and was described by commercial experts as of fair quality, and worth at that time 12*s*. to 13*s*. per lb.

Clove Leaf Oil.

A sample of this oil was received from the Seychelles in June 1907. It was produced by a firm which has set up a small still at Mahé for the production of essential oils. The sample was light-brown in colour, highly refractive and possessed a characteristic odour of eugenol. It had specific gravity at 15° C. 1·0489, optical rotation in a 10 cm. tube $-1° 35'$, was soluble in its own volume of 70 per cent. alcohol, and contained 87 per cent. of eugenol. Since that date a small quantity of the clove leaves from which this oil was distilled has been received at the Imperial Institute, and by distillation of these it was ascertained that the yield of oil is 4·5 per cent. The small quantity of oil thus prepared agreed in all respects with that sent from the Seychelles. The oil was submitted to experts for valuation, who stated that it was of good quality, very fragrant, and worth from 4*s*. 4*d*. to 4*s*. 6*d*. per lb. (August 1907).

Cinnamon Bark Oil.

A small sample of this oil was received for examination in July 1907. It consisted of pale yellow oil, with a cinnamon-like odour and spicy taste, and was faintly turbid. It had specific gravity 0·943, optical rotation $-4° 30'$ in a 10 cm. tube, was incompletely soluble in 12 parts of 70 per cent. alcohol, but soluble in 1·5 parts of 80 per cent. alcohol, and contained 8·0

per cent. of "phenols" (eugenol) and 21·7 per cent. of aldehydes (cinnamic aldehyde). The oil differs markedly from the cinnamon bark oil of commerce, and would not be saleable as such in the United Kingdom.

The Colonial Report on the Seychelles for 1906 [Cd. 3285–7] states that distilling apparatus for the production of essential oils has been set up at Sans Souci in Mahé, and also in Silhouette, so that a commercial production of some of the oils referred to above may be expected in the near future. It appears that large numbers of cinnamon trees are available in the Seychelles for the production of bark.

2. CITRATE OF LIME.

Citrate of lime manufactured in the Island of Silhouette was forwarded to the Imperial Institute in 1906. It consisted of one pound of a pale-green powder, which had a slight, pleasant odour. When moistened the citrate of lime showed a faint greyish orange-brown colour, and gave a yellow solution when dissolved in water.

On analysis it was found to contain 84·56 per cent. of citrate of lime (calcium citrate) and 0·42 per cent. of free acid calculated as citric acid, these two constituents being together equivalent to 66·89 per cent. of crystallised citric acid. It contained a small quantity of iron salt, equivalent to 0·7 per cent. of ferric oxide, and also a little nitrogenous and mucilaginous organic matter. The proportion of moisture, including water of crystallisation, was 12·57 per cent.

The analytical results show that this sample of citrate of lime is of good quality, and that it contains very little organic impurity. No excess of calcium carbonate is present but the amount of ferric oxide is rather high, owing probably to the use of impure chalk in the preparation of the product. Care should be taken to use a white chalk free from rusty patches for the neutralisation of the juice.

The amount of moisture is also rather high, viz. 12·57 per cent. Air-dried citrate of lime ought to contain only about 7 to 8 per cent. of moisture, and it is desirable that this percentage should not be greatly exceeded in commercial consignments.

A portion of the sample was submitted in 1906 to a firm

of manufacturing chemists in London, who use considerable quantities of citrate of lime. This firm reported that the quality of the product is extremely good, especially as regards colour, percentage of citric acid, and freedom from lime and mucilage. In these respects it is superior to many commercial samples. The chief defect is that more iron is present than usual, but, as already pointed out, this can be easily remedied in future by carefully selecting the chalk used for neutralising the juice.

3. DRIED BANANAS.

Three samples of dried bananas were forwarded in June 1905, in order that their commercial value in this country might be ascertained. They were labelled as follows :—

I. "Farine de bananes d'une teinte orange claire."

II. " „ „ „ grise claire."

III. "Bananes séchées avec lesquelles sont produit la farine de teinte orange."

These products are prepared from bananas known locally as "bananes malgaches" and "bananes St. Jacques," both of which are stated to be peculiar to the Seychelles and to be forms of *Musa sapientum*, var. *paradisiaca*, Linn. Recently a third variety, "banane carre," which is resistant to weevils, has also been used.

The two specimens of flour, "orange" and "grey," were in the form of fine powder, and had evidently been carefully prepared. They possessed a faint agreeable aroma, which was practically identical in the two cases, but in point of colour and flavour the "orange" flour was distinctly superior.

Both specimens were submitted to chemical examination, and were found to have the following percentage composition :—

	I. "Orange."	II. "Grey."
Water	9·60	12·06
Albuminoids (calculated from total nitrogen)	3·00	4·80
Starch, etc. (by difference)	83·54	77·87
Sugar (glucose)	0·94	1·84
Fat	0·32	0·44
Fibre	0·79	0·70
Ash	1·81	2·29
Phosphoric acid, in flour	0·13	0·17

These results, which are in general agreement with previously recorded analyses of banana meal and flour, show that the material is relatively rich in carbohydrates and mineral matter (ash), but poor in proteid. Its nutritive value is therefore low, being much less than that of white wheaten flour, which usually contains from 8 to 11 per cent of albuminoids, and also less than that of rice. Of the two samples under consideration the grey flour is distinctly superior to the "orange" in nutritive value, as it contains more albuminoid matter and also a higher percentage of phosphates.

Within recent years banana flour has been introduced into this country from the West Indies, and a limited demand for the product has been created. It is used, in conjunction with other materials, for the preparation of bread, invalid foods, and other dietetic specialities, and also to some extent in biscuit manufacture.

Samples of the two flours and of the dried bananas, from which the "orange" flour was prepared, were submitted for criticism and valuation to a manufacturer who has made a speciality of these products. After practical trials he reported that the "orange" flour possessed an excellent colour and flavour and would be very suitable for manufacturing purposes, as it could be utilised for all kinds of banana preparations. The "grey" flour, although of higher nutritive value than the "orange," was less satisfactory in colour and flavour, and its use would be restricted to those preparations in which its dull colour would not be objectionable. He valued the "orange" flour at 20*s.* per hundredweight, the "grey" at 16*s.* per hundredweight, and the dried bananas at 18*s.* per hundredweight delivered in London.

He stated that in his opinion it will probably be found most advantageous to export the dried bananas rather than the flour, as the manufacturer could grind and dress the flour to suit his particular purpose, and thus ensure absolute uniformity of the product. One of the great obstacles to the use of banana flour at the present time is the extreme variation in character which is frequently exhibited by commercial consignments from the same source, and this fact militates against its regular use for many purposes.

Great care has to be exercised in the preparation of the dried

bananas in order that the colour and flavour of the flour may always be the same. The best time to collect bananas required for the preparation of flour is said to be when the skin is just turning colour. In the Seychelles special apparatus for drying bananas has been erected in which the fruits are dried in about 18 hours at a temperature not exceeding 65° to 70° C. Ten tons of dried bananas were exported in 1906 and it was expected that 50 tons would be produced in 1907 (*loc. cit.* p. 40).

Samples of preserved plantains and of a coffee substitute prepared from bananas have also been received from the Seychelles for examination, but inquiry shows that neither of these products is likely to find any considerable market in the United Kingdom.

4. ORCHELLA WEED.

Four samples of orchella weed from Aldabra, Seychelles, were forwarded for examination in December 1906.

The samples have been chemically examined in order to determine their value as a source of orchil dye and the following results were obtained :—

No. 1	contained	the equivalent	of 11·5	per cent.	of orcinol.
No. 2	"	"	1·6	"	"
No. 3	"	"	8·8	"	"
No. 4	"	"	9·3	"	"

Orcinol exists in the lichen usually in combination in the form of acids. Stenhouse states that lichens of this type may contain from two to twelve per cent. of orcinol-yielding acids. The determinations of orcinol given above were made by a modification of Stenhouse's process (see p. 210).

The samples were submitted for valuation to a firm of brokers, who reported that Nos. 1, 3, and 4 were nominally worth about 7*s.* per cwt. in London ; No. 2 was stated to be of inferior quality. They pointed out, however, that there is at present only a limited demand and consequently a very small market for orchella weed.

A firm of manufacturing chemists who prepare orchil dyes was also consulted. They reported that the orchella weed from Seychelles, although of good quality, was not equal to the shorter and flatter Ceylon variety, and stated that the demand for

orchil and cudbear produced from these lichens had fallen off considerably during the last twenty years, and that the value of orchella weed has consequently fallen from £40 to £10 per ton for some kinds, and as low as £7 to £8 for Californian weed. In their opinion samples Nos. 1, 3, and 4 were of about equal value and might realise from £10 to £12 per ton in London, but No. 2 was valueless.

With regard to the present trade in orchella weed it is stated that there are now only about four firms in the United Kingdom producing orchil dyes, and the consumption of the weed in this country cannot be much above 1,000 bales per annum.

The imports into Liverpool during 1905 were 2,145 bales, some of which were re-exported, whilst in 1906 the quantity fell to 1,454 bales.

The results of the inquiry show that at present only a very limited demand exists for orchella weed or its products, and it therefore appears doubtful whether any considerable export trade in the material could be developed in the Seychelles.

5. KAPOK.

This material, received in 1906, was labelled "Sample of kapok, Mahé, Seychelles," but no information was given regarding its botanical origin. It was a light silky floss of pale cream colour, and contained some small particles of woody material and a few seeds, the latter resembling those of the tree *Eroidendron anfractuosum*, which yields genuine kapok.

The floss was chemically examined in comparison with a commercial specimen of genuine Java kapok, and the following results were obtained :—

	Seychelles kapok. *Per cent.*	Java kapok. *Per cent.*
Moisture	10·0	10·9
Ash (on dry fibre)	2·08	1·3
Cellulose (on dry fibre)	61·3	64·3
Length of fibres	0·75 inch	—

These figures indicate that in composition, as in appearance, the kapok from Seychelles closely resembles the product from Java, and, as *Eroidendron anfractuosum* occurs in the islands, it

is probably derived from the same tree. There is no doubt, that material represented by this sample could be utilised commercially for the same purposes as Java kapok.

A sample was submitted for valuation to commercial experts, who reported that the material was of very nice quality, but pointed out that it should be thoroughly freed from the seeds and fragments of pod before exporting to this country. It was valued in 1906 by manufacturers at 4*d.* to 4⅛*d.* per pound, but similar material if properly cleaned would probably realise ½*d.* per pound more. The usual price of Java kapok in the London market is from 4*d.* to 5*d.* per pound.

6. GUTTA PERCHA AND RUBBER.

These specimens of gutta percha and rubber were forwarded to the Imperial Institute by the Governor of Seychelles in January 1904, with a request that they should be examined in the Scientific and Technical Department in order to ascertain their composition and commercial value.

Four samples were submitted, two of which represented the product yielded by the Capucin tree, *Northea seychellana*, whilst the others had been prepared from two species of *Ficus*.

"Gutta percha" from the Capucin Tree.

The Capucin tree, *Northea seychellana*, is a member of the natural order Sapotaceæ, to which the trees yielding true gutta percha (*Dichopsis Gutta*, etc.) also belong. Its latex is said to flow freely on tapping.

The two samples of the product had been prepared in different ways, one by heating the latex at 100° C., and the other by evaporating it to dryness in a cool place.

No. 1. "Capucin milk coagulated by heating at 100° C."

The sample consisted of two circular cakes, each about three inches in diameter and one-eighth of an inch thick, which together weighed 33 grams. The material somewhat resembled gutta percha in appearance and properties. It was greyish-white, fairly hard, and inelastic in the mass; it possessed a slightly fibrous structure but exhibited little tenacity, the cakes breaking easily with an irregular fracture. Small pieces softened

and could be moulded when held in the fingers. When treated with hot water the material became soft and sticky, but hardened again on standing.

No. 2. "Capucin milk coagulated by evaporation to dryness, temperature 24° C."

This was a single cake, weighing 103 grams, which was light-brown externally but greyish-white within. It showed a laminated structure and was much more brittle than the preceding specimen, with which it otherwise agreed in properties.

A preliminary chemical examination showed that these products from the Capucin tree are more closely related in composition to gutta percha than to rubber, as they contain no caoutchouc but a substance similar in character and properties to gutta, the characteristic constituent of true gutta percha. The following figures were obtained on analysis:—

	Samples as received.		Composition of dry material.	
	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	3·1	12·5	—	—
Resin	67·4	55·6	69·5	63·5
Gutta	20·1	10·2	20·8	11·7
Insoluble matter	9·4	21·7	9·7	24·8
Ash	7·5	8·2	7·7	9·4

These results show that the material is largely composed of resins, and that only small amounts of the gutta are present. The gutta is of inferior quality to that obtained from true gutta percha, being very deficient in strength. It is noteworthy that almost the whole of the ash from both specimens consisted of lime. Material of this character would have little, if any, commercial value.

Ficus Rubber.

The two specimens of Ficus rubber submitted for examination were derived from *Ficus rubra* and *Ficus elastica* respectively.

The *Ficus rubra* is known as "Lafouche" in Seychelles, where the tree is very abundant, owing to the fact that it is valueless as timber. It is stated to yield an enormous amount

of latex, which coagulates freely and contains a very high percentage of rubber.

Ficus elastica is the Assam rubber tree, which has been introduced into Seychelles.

No. 3. "Lafouche milk coagulated by heating at 100° C."

The sample consisted of two circular cakes, each about four inches in diameter and half-an-inch thick, which together weighed 140 grams. Like many of the products yielded by other species of Ficus, the material resembled gutta percha rather than rubber in appearance and properties, but its relation to rubber was shown by the fact that it contained a small amount of inferior caoutchouc.

The cakes differed somewhat in appearance. One was a light pinkish colour, both externally and internally, and was rather hard and brittle, breaking with a short fracture. The other was dark chocolate-brown on the outside and dirty-white within; it was not so hard as the preceding specimen and showed a more granular structure. In composition and properties, however, the two cakes were practically identical.

The results of the analysis were as follows:—

	Per cent.
Moisture	0·1
Caoutchouc	15·9
Resin	82·5
Insoluble matter	1·5
Ash	0·23

The product from *Ficus rubra* is therefore of very inferior quality considered as a rubber, since it contains less than 16 per cent. of inferior caoutchouc and 82·6 per cent. of resin. As already noted, the material resembles gutta percha rather than rubber in properties, and in this respect, as also in composition, it agrees with the products yielded by many other species of Ficus. It would have no commercial value.

No. 4. "*Ficus elastica* milk coagulated by heating at 100° C. and dried in the shade."

This was a flat strip of rubber, measuring $8'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$, and weighing 54 grams. It had a distinct purplish colour, which was

most pronounced on the outside. The rubber was not sticky, but was very deficient in elasticity and tenacity, and was evidently of rather inferior quality.

An analysis furnishes the following results :—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	8·6	—
Caoutchouc	45·3	49·6
Resin	44·6	48·8
Insoluble matter	1·5	1·6
Ash	0·21	0·23

The rubber is therefore of poor quality, containing almost equal proportions of caoutchouc and resin. In the absence of detailed information regarding the experiments, it is impossible to indicate the reason for the high percentage of resin, but the explanation may possibly be that the latex was obtained from young trees. A previous sample of *Ficus elastica* rubber from Seychelles, received at the Imperial Institute in 1902, was of much better quality, so far as chemical composition is concerned, than that now under notice, as it contained 88 per cent. of caoutchouc and 11·6 per cent. of resin.

Although the rubber was not very satisfactory, either in composition or in properties, it was submitted to brokers for valuation. They reported that consignments of similar quality might possibly realise about 2*s.* per lb. in the London market (May 1904), but they pointed out that this valuation must be regarded as only approximate. Fine Para rubber was quoted at 4*s.* 8*d.* per lb. on the same date.

It should be added that experimental plantations of *Hevea brasiliensis* and *Manihot Glaziovii* have been formed in the Seychelles by the Government, and that *Funtumia elastica*, *Castilloa elastica*, *Ficus elastica*, *Cryptostegia madagascariensis* and *Landolphia madagascariensis* are also being tried.

A few planters have raised plants from Para rubber seed imported from Ceylon, and at the end of 1906 the Curator of the Botanic Garden estimated that apart from 50,000 seedlings there were 25,000 plants 1 year old, 2,000 plants 2 years old, 100 plants

3 years old, and 1,000 plants 4 years old already in the Colony (*loc. cit.* p. 42).

7. MANGROVE BARKS.

A full account has been published already in this *Bulletin* (1907, **5**. 349) of the results of the examination of barks obtained from the chief species of mangroves found in the Seychelles, and it was shown that barks of marketable quality are obtainable from several of these, the bark richest in tannin being that of *Bruguieria gymnorrhiza.* From information subsequently received from the Governor of the Seychelles it appears that Aldabra island possesses the largest supplies of mangroves, the quantities available on the other islands being negligible except perhaps on Cosmoledo island, which has not been fully explored. It is estimated that the total area of Aldabra is about 38,000 acres, with a central lagoon of about 40,000 acres The mangrove forests fringe the lagoon to an average depth of about a quarter of a mile, and this fringe is pierced here and there by narrow channels permitting of the mangrove forests being worked by means of flat-bottomed boats. Unfortunately there are strong tidal currents in these channels, and some difficulty has been experienced in obtaining men to work at the irregular hours which suit the tides. It is estimated that a man can collect from 200 to 300 lb. of green bark per day, and that a woman or child can scrape off the useless outer layer from 100 lb. of bark in the same time. The following are the estimated yields of green and dry bark from mature trees of the species mentioned :—

	Green bark. *lb.*	*Dry bark.* *lb.*	*Loss on drying.* *Per cent.*
Rhizophora mucronata . .	72	43	40
Bruguieria gymnorrhiza .	34	14·5	57
Ceriops Candolleana . .	27	16	41
Avicennia officinalis . .	70	39·5	44

It is satisfactory to find that of the 2,950 acres estimated to be occupied by mangrove forests, 1,960 are occupied by *Bruguieria gymnorrhiza*, which yields the bark richest in tannin, whilst 365 acres are covered by *Rhizophora mucronata* and 625 acres by *Ceriops Candolleana*, which yield barks containing 34 to 35 per

cent. of tannin which may prove to be marketable. It is stated that up to March last 800 tons of mangrove bark had been collected on Aldabra island and were then awaiting shipment.

8. MOTHER-OF-PEARL SHELLS.

This collection of shells was forwarded to the Imperial Institute by the Governor of the Seychelles in October 1904, with a request that information might be supplied as to the commercial value of the shells and the best markets for their disposal.

A preliminary examination of the collection showed that it contained five types of shells. It was accordingly classified, and typical specimens of the various classes submitted for valuation to commercial experts, who reported on them as follows :—

	Description.	*Commercial Value.*
Sample A.	"Coppery Madagascar"	About 50*s.* per cwt.
Sample B.	"Small to bold mussel shells"	About 30*s.* to 40*s.* per cwt.
Sample C.	"Manilla mother-of-pearl shell"	About £5 per cwt.
Sample D.	"Sharks Bay shell"	About 35*s.* per cwt.
Sample E.		No commercial value.

9. NATURAL PHOSPHATE DEPOSITS.

In April 1905 two samples of phosphatic material described as guano were forwarded by the Curator of the Botanic Station to the Imperial Institute for examination in the Scientific and Technical Department. Specimen No. 1, labelled "Phosphatic rocks, sub-layer," was found to consist of small pulverulent lumps of a pale buff colour, and to contain a large proportion of white shell fragments. The other, labelled "Seychelles guano, surface-layer," consisted of a coarse powder of dark, earthy colour, associated with rootlets, small shells, and granules of calcium carbonate.

The samples were analysed, with the results shown in the table on p. 123. On representative samples being submitted to brokers and chemical manure merchants, they reported that the sub-layer, which was poorer in phosphates and nitrogen, was worth from £2 to £2 5*s.* per ton, and the sample from the surface from £2 10*s.* to £3 5*s.*

In May 1906 two further samples, described as "phosphate rock, composed of a coral basis impregnated with guano," were

received from the Seychelles, with the request that the proportion of phosphoric acid present might be determined and information supplied as to the possibility of finding a market. One sample, marked "Alphonse Island," consisted of lumps of a light chocolate-brown material, containing white nodules distributed evenly through it, and the other, marked "Marie Louise Island," was earthy in colour, and coarser in texture, while the white nodules were much larger. The results of the analysis of these specimens are given in the table below. They proved to consist of phosphatic material of considerable value, comparing favourably with the mineral phosphates now exported on a large scale from Tunis, Florida, and elsewhere. The phosphate from Tunis contains, as a rule, about 63 or 64 per cent. of tricalcic phosphate, while that from Florida may contain as much as 78 or 79 per cent. (see this *Bulletin*, 1908, **6**. 81).

Constituent.		Sub-layer.	Surface layer.	Sample from Alphonse Island.	Sample from Marie Louise Island.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Lime	CaO	47·80	36·01	45·10	46·90
Ferric oxide	Fe_2O_3	—	—	0·17	0·08
Alumina	Al_2O_3	—	—	0·28	0·45
†Phosphoric anhydride .	P_2O_5	23·45	29·02	29·26	30·84
*Carbon dioxide . . .	CO_2	12·33	1·89	4·61	5·54
Total nitrogen . . .	—	0·54	1·33	0·45	0·25
†Equal to tricalcic phosphate	$Ca_3P_2O_8$	51·24	63·41	63·72	66·99
*Equal to calcium carbonate	$CaCO_3$	—	—	10·46	12·57

The samples were reported on very favourably by dealers to whom they were submitted. It was stated that the price per ton of Algerian and Tunisian phosphates was 5½*d.* to 6*d.* per unit per cent. of tricalcic phosphate for low grade, and from 6*d.* to 7*d.* for high grade material, and that pebbly phosphate from Florida containing about 70 per cent. of tricalcic phosphate and 2·5 to 3 per cent. of alumina and oxide of iron was sold at about 7*d.* per unit. These samples from the Seychelles would, therefore, be worth about 7*d.* per unit of tricalcic phosphate, or 35*s.* to 40*s.* per ton, c.i.f. in European ports in cargoes of 2,000 to 3,000 tons. The material appears, as in other cases, to be formed by the alteration of coral limestone by the infiltration of phosphates from the overlying deposits of guano. This view is

supported by the presence of remains of coral in the phosphatic material. The commercial exploitation of the deposits has now been arranged for.

In November of the same year a number of samples described as corals collected at Bassin de la Plaine des Cabris, Aldabra, were received from the Seychelles. Most of them proved to consist of calcium carbonate, with only a small percentage (usually less than 1) of phosphoric acid, and were of no value for export. Sample No. 2, however, described as "loose fragment collected on the floor of the basin," contained 75·8 per cent. of tricalcic phosphate. It was finely crystalline, and yellow to reddish in colour, and its commercial value was estimated at 8½*d.* per unit, or £2 13*s.* 8*d.* per ton.

Sample No. 6, described as "fragments detached from the east side of the basin where the coral is coated with colouring matter," consisted of two pieces, both of which were covered with a superficial red film. One was merely compact travertine (carbonate of lime deposited from solution), while the other contained 65 per cent. of tricalcic phosphate, so that its commercial value would be 7½*d.* per unit, or £2 1*s.* 5*d.* per ton.

Sample No. 8, "coloured coral," was part of a large fragment found in the middle of the basin. It consisted of reddish phosphate of calcium with a superficial coating of calcareous material. It contained 81 per cent. of tricalcic phosphate, and its value was estimated at 9*d.* per unit, equal to £3 1*s.* 2*d.* per ton.

From the examination of these samples it would seem that the main mass of the material forming the bottom and sides of the shallow Bassin de la Plaine, consists of calcium carbonate, containing less than 1 per cent. of phosphoric acid. On the eastern side of the basin where the coral is coloured, the calcium carbonate has been to a large extent replaced by calcium phosphate, but this does not appear to extend far into the coral, so that the phosphate rock occurs only in the form of a thin coating or loose fragments. This side of the basin must have been once covered by guano from which the phosphoric acid is derived. The samples above described as containing a high percentage of phosphate would be readily saleable in the United Kingdom and other European countries where there is a demand

for phosphatic manures, but the value of the deposit must depend on its amount and the facility with which it can be worked.

Samples that do not contain sufficient phosphate for export may be of some value locally for manuring purposes.

10. LATERITE.

In the latter part of the year 1907 four samples of ferruginous decomposition products, referred to as laterite, were received at the Imperial Institute from the Curator of the Botanic Station. Sample No. 2 from "Mon Plaisir" formed a yellow crust on basaltic rock. An analysis furnished the following results:—

		I.	II.	III.	IV.
Alumina	Al_2O_3	37·12	27·20	40·80	32·42
Ferric oxide	Fe_2O_3	19·94	28·99	12·70	12·60
Silica	SiO_2	17·58	16·35	19·41	35·55
Titanic oxide	TiO_2	2·23	4·20	2·55	2·45
Loss on ignition	—	23·00	22·01	24·03	17·03

For comparison with these results, the following figures, representing the average composition of some of the principal minerals employed in the manufacture of (1) aluminium and alumina, and (2) aluminous salts, may be quoted:—

		Minerals used for making alumina and aluminium.		Minerals used for making aluminous salts.	
		French red bauxite.	Irish bauxite.	Bauxite from Arkansas.	Cornish china clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Alumina	Al_2O_3	57·0	42·0	54·0	39·3
Ferric oxide	Fe_2O_3	21·0	2·0	3·0	1·0
Silica	SiO_2	3·0	13·0	9·0	50·5
Titanic oxide	TiO_2	2·0	6·0	2·0	—
Loss on ignition	—	17·0	37·0	32·0	9·2

Comparing these figures, it will be seen that the Seychelles laterites are too poor in alumina, and contain too much silica to be suitable for the manufacture of alumina and aluminium, and, on the other hand, they contain too little alumina and too much ferric oxide to be suitable for the preparation of alum and other aluminous salts.

It is doubtful whether if better material of this type were discovered in Seychelles it would prove remunerative to ship it

to Europe, since the present value of bauxite is from 22*s.* to 23*s.* per ton delivered at ports in the United Kingdom, and the price of China clay is only about 30*s.* per ton in this country. Such prices would probably not cover the cost of extracting the material in the Seychelles and of shipping it to the United Kingdom.

JUTE AND JUTE SUBSTITUTES FROM WEST AFRICA.

IN previous numbers of this *Bulletin* (1905, **3.** 251 ; 1907 **5.** 2) attention has been drawn to the question of the production of jute and similar fibres in British West Africa, and accounts have been given of the results of the investigation of various samples of these materials in the Scientific and Technical Department of the Imperial Institute. Further specimens have been received and are described briefly in the following pages.

JUTE (*Corchorus* sp.).

Southern Nigeria.—Two samples received from Lagos were matted, tangled and weak, and only suitable for use as tow. It was pointed out that the lack of strength was probably due to over-retting, which in future should be carefully avoided, and that it is important that the fibre should be kept straight and not allowed to become tangled.

A specimen of jute (*Corchorus olitorius*) grown on the Onitsha Plantation was harsh, of pale buff colour and fair lustre, and somewhat frayed. It was of poor strength and was valued at £14 10*s.* per ton (with "medium" jute at £14–£16 per ton). It seemed probable that this sample had also been retted for too long a period.

Another sample of the fibre of *C. olitorius* received was of similar character, but of inferior quality. It was accompanied by a specimen, the product of *C. capsularis*, which, although apparently containing some good fibre, was not sufficiently prepared to be saleable in this country at a remunerative price.

A sample of jute (*C. capsularis*, green stem) from the Western Province consisted of soft, well-prepared, lustrous fibre. It was of good length and strength and was regarded by commercial

experts as equal to "good medium" Bengal jute and worth £15–£16 per ton (with "first marks" Calcutta jute at £14 per ton). The product was of very good quality, but would have been improved if about six inches of the rough root end had been cut off as is done in Bengal. Consignments of this quality would be readily saleable in this country to users of Bengal jute. The sample was accompanied by a specimen of *C. capsularis* (red stem) fibre of similar quality, but somewhat darker in colour. It was valued at £13–£14 per ton and was said to be saleable in any quantity.

Northern Nigeria.—Two samples of jute from Northern Nigeria, one from imported seed, and the other from local native seed, were received for examination. The former consisted of soft, fine, greyish, fairly lustrous fibre, but was not very well cleaned. The fibre was about four feet long and was regarded by experts as very suitable for the best purposes of jute spinning, and worth £24 per ton (with "medium" jute at £23–£25 per ton). It was pointed out that the fibre could be considerably improved by more careful preparation. The sample grown from native seed was harsher and more brittle and not very well prepared. It was valued at £22 per ton.

A specimen of native jute cultivated by riverside villagers in Borgu Province, Northern Nigeria, consisted of nearly white, fairly well cleaned, rather harsh fibre, about five feet long and rather weak. On chemical examination it gave the following results:—

	Per cent.
Moisture	9·0
Ash	0·3
α-Hydrolysis (loss)	9·8
β-Hydrolysis (loss)	15·1
Acid purification (loss)	0·1
Cellulose	76·5

These results show that the sample was on the whole of good quality. It was, however, slightly inferior to a specimen of "extra fine quality" Indian jute with which it was compared, as it contained less cellulose and suffered a greater loss on hydrolysis than the latter.

Sierra Leone.—A specimen of the fibre of *C. capsularis* grown at Kangahun was composed of fine, soft, silky, lustrous fibre, of good colour but poor strength, and was valued at £22–£23 per ton (with "medium" jute at £22–£25 per ton). This fibre was well cleaned but had probably been over-retted.

Another sample from Sierra Leone consisted of unevenly prepared fibre about four feet long, of fair lustre, colour varying from pale buff to grey, and of irregular strength. Portions of the material were still gummy, but the greater part had been over-retted. The fibre was valued at £9 per ton (compared with Calcutta jute at £14 10*s.* per ton). Suggestions were made with reference to the retting process with a view to the production of a more regular and evenly cleaned product.

JUTE SUBSTITUTES.

Hibiscus esculentus.

Southern Nigeria.—A sample of the fibre of *Hibiscus esculentus* from Southern Nigeria was of uneven quality. The best portion was almost white, lustrous, rather harsh and not very well cleaned and prepared; the remainder was of darker colour and of irregular staple. The product was valued at £18 per ton (with "medium" jute at £23–£25). The harshness of the fibre suggested that it had been prepared from old plants, and it had evidently been insufficiently retted.

Sierra Leone.—A specimen of "Okra" fibre from Sierra Leone was well cleaned, soft, nearly white, lustrous, and of fairly good strength. It was about five feet long, and on chemical examination gave the following results :—

	Per cent.
Moisture	10·6
Ash	0·2
α-Hydrolysis (loss)	8·8
β-Hydrolysis (loss)	14·0
Acid purification (loss)	0·9
Cellulose	72·4

The fibre compared favourably with a sample previously examined (this *Bulletin*, 1905, **3**. 257). The proportion of cellulose was lower, but the comparatively small losses on

hydrolysis showed that the fibre was likely to resist the action of water satisfactorily. This product was well grown and beautifully prepared; it was valued at £20 per ton (with "medium" jute at £15–£17 per ton), and was said to be readily saleable in large quantities. This sample of fibre was prepared from "Okra" plants cut after the first crop of fruits had been gathered; it was pointed out that it would be necessary to examine specimens prepared at different stages of growth, before the best period for cutting the plants for the production of fibre could be determined.

In accordance with this suggestion, three samples of "Okra" fibre (Nos. 1, 2, 3) have been extracted after the first, second and third crops of fruit had been gathered. Sample No. 1, collected after the first crop of fruit, consisted of rather soft, nearly white, lustrous fibre, which was well cleaned, but ragged in general appearance. The product was of good strength and four to five feet long. The material yielded the following results on chemical examination :—

	Per cent.
Moisture	8·2
Ash	0·2
α-Hydrolysis (loss)	8·0
β-Hydrolysis (loss)	13·8
Acid purification (loss)	0·3
Cellulose	74·0

This fibre was valued at about £14 per ton (with "medium" jute at £14–£16 per ton).

Sample No. 2, prepared from the stems after the second series of fruits had been gathered, resembled No. 1, was of good strength, and about four to six feet long.

On chemical examination it gave the following results :—

	Per cent.
Moisture	10·3
Ash	0·3
α-Hydrolysis (loss)	7·3
β-Hydrolysis (loss)	11·9
Acid purification (loss)	0·6
Cellulose	77·3

This fibre was distinctly superior to the other two samples; it suffered a smaller loss on hydrolysis and contained a higher percentage of cellulose. The material would be suitable for mixing with high grade jute, but was rather more brittle than ordinary Calcutta jute. It was regarded as worth £18–£20 per ton (with "medium" jute at £14–£16 per ton, and "fine" jute at £16–£25 per ton).

Sample No. 3, prepared from stems after the third and last crop of fruit had been gathered and when the stems were getting dry, consisted of nearly white, fairly lustrous fibre, but was not so well cleaned as Nos. 1 and 2. It contained a quantity of entire ribbons and some knots, and parts of the sample were ragged. The strength was very uneven, being on the whole rather poor and brittle. The fibre varied in length from five to eight feet, and on chemical examination gave the following results:—

	Per cent.
Moisture	9·3
Ash	0·2
α-Hydrolysis (loss)	9·5
β-Hydrolysis (loss)	13·9
Acid purification (loss)	1·0
Cellulose	72·7

The product was regarded as rather too brittle for use as a jute substitute, but it was thought that it might possibly be suitable for rope-making in conjunction with the so-called China jute (*Abutilon Avicennæ*). It was regarded as worth £15 per ton (with "medium" jute at £14–£16 per ton, and China jute at £13–£17 per ton).

From the examination of these three samples it appears that the "Okra" fibre obtained after picking the second crop of fruits was superior to the other two specimens, as it suffered a smaller loss on hydrolysis and contained a higher percentage of cellulose. It should therefore resist the action of water better.

Sample No. 3 was of very good length, but was brittle and of poor strength. This brittleness could not be attributed to over-retting, as the fibre was gummy and appeared to have been insufficiently cleaned. It is possible that the dry condition of

the stems before cutting may have had something to do with this weakness.

Hibiscus quinquelobus.

Sierra Leone.—A consignment of about one ton of "Kowe" fibre (*Hibiscus quinquelobus*) was forwarded to the Imperial Institute in April 1907. The product consisted of brownish-white ribbons composed of interlacing fibres which were slightly lustrous, well cleaned, rather harsh, of fair but uneven strength, and irregular length varying from three feet six inches to six feet. On chemical examination it furnished the following results:—

	Per cent.
Moisture	11·5
Ash	0·2
α-Hydrolysis (loss)	6·0
β-Hydrolysis (loss)	8·5
Acid purification (loss)	0·2
Cellulose	78·0

These figures show that in chemical composition and behaviour, the sample was very similar to the "Kowe" fibre examined previously at the Imperial Institute (this *Bulletin*, 1907, **5**. 5). The loss on hydrolysis was unusually low and indicated that the fibre would prove durable. The product was sold at public auction in London with the result that a portion of the material realised £18 per ton, whilst the remainder sold at £17 5*s*. per ton. The brokers who sold the consignment reported that £18 per ton was about the price, subject to market fluctuations, which might be expected for future lots of this fibre, for which it seemed possible that a demand might be created. They suggested that five tons of the fibre should be regularly placed on the market every month as a beginning.

Hibiscus lunariifolius. (?)

Northern Nigeria.—A sample of "Ramma" fibre from Northern Nigeria consisted of brownish-white fibre which was on the whole well prepared, but insufficiently cleaned in parts. The

product possessed good lustre and strength and varied in length from three to seven feet. On chemical examination it yielded the following results :—

	Per cent.
Moisture	8·5
Ash	0·4
α-Hydrolysis (loss)	7·4
β-Hydrolysis (loss)	10·2
Acid purification (loss)	0·4
Cellulose	76·8

The fibre suffered comparatively small loss on hydrolysis, and would therefore resist the prolonged action of water. The product was too harsh for use as a jute substitute, but would make strong and durable ropes. It was regarded by experts as worth about £12 per ton (with "common" jute at £11–£12 per ton).

A specimen of brown ribbons of "Ramma" bark was received from Northern Nigeria at a later date. These ribbons were tough and gummy, and about six feet long. In this condition the product could only be used as a paper material and would probably be worth about £4 per ton. It was suggested that experiments should be made to prepare the fibre by retting the stems in a similar manner to that employed in the extraction of jute.

Honckenya ficifolia.

Sierra Leone.—Two samples of "Napunti" fibre (*Honckenya ficifolia*) were received from Sierra Leone. One of these samples consisted of narrow, light-brown ribbons of soft, fairly lustrous fibre, which was well cleaned and prepared but tended to split up on hackling. The product was of poor strength and three to four feet long. It was regarded as probably worth £10–£11 per ton (with "common" jute at £11–£13 per ton).

The other samples consisted of dirty, buff-coloured ribbons, which were nearly black in parts, of poor lustre and imperfectly prepared. After the fibre had been cleaned a brownish-white, fairly lustrous, soft, fine fibre was obtained. The sample was of

uneven but fairly good strength, and four to six feet long; its bad colour was mainly due to dirt, and its appearance could be considerably improved by washing. If the fibre had been more thoroughly cleaned, its value would have been equal to that of "medium" jute.

A sample of "Napunti" fibre collected from young plants of the first year's growth, before they had flowered, consisted of soft, fine, greyish fibre of rather poor lustre, and had been well cleaned but probably over-retted, as its strength was very poor. It was from three feet to three feet six inches in length, and was regarded as worth about £20 per ton (with "medium" jute at £22–£25 per ton, and "common" jute at £18 10*s*.–£20 per ton).

Two other samples, which were collected from old plants after flowering, were of little value, as they consisted of ribbons and tended to split up into short pieces on combing.

In connection with another sample of "Napunti" fibre, it was stated that the material represented the only form in which the natives could prepare this fibre, and it was consequently desired to ascertain whether it would have any commercial value. It was thought that the natives could make a profit from the sale of such fibre at ½*d*. per lb. or even less.

The sample consisted of a large bale of coarse, brown, fibrous, bast ribbons, which were woody and gummy. The length of the ribbons was from three to four feet.

Chemical examination of the material gave the following results:—

Moisture	9·0 per cent.
Ash	4·0 „ „ on dry material
Cellulose	55·0 „ „ „ „
Length of ultimate fibre	1·4 mm. to 3·0 mm. (mean 2·1 mm.) or 0·056 to 0·12 in. (mean 0·08 in.).

The fibre in this form appeared to be only suitable for use as a paper-making material, and the results of the chemical examination showed that the ribbons contained about the same percentage of cellulose as esparto grass.

Owing to the bulky nature of the "Napunti" ribbons, it

seemed doubtful whether the exportation of the fibre in this form would be remunerative in view of the cost of transport.

A sample of the ribbons was submitted to a paper expert for an opinion regarding the suitability of the material for paper-making. He reported that it could be used for the manufacture of paper, but that he could not recommend bringing the raw material to England. It would be better, he thought, to consider the advisability of treating the material before shipment and reducing it to a condition of unbleached "half-stuff," leaving the paper-maker to bleach it as required. In the expert's opinion the unbleached "half-stuff" would probably fetch from £7 to £8 per ton if sold in sufficient quantity of uniform quality.

Special experiments, however, proved that the Napunti ribbons as received yielded 47·3 per cent. of air-dry "half-stuff," containing 8 per cent. of moisture. Consequently over two tons of ribbons would be required to furnish one ton of "half-stuff."

In view of these results it was considered extremely doubtful whether the course suggested by the expert would be remunerative. The cost of preparing the crude ribbons was given as ½*d.* per lb. (£4 13*s.* 4*d.* per ton) or even less, and as the material yields less than half its weight of "half-stuff" valued at £7 to £8 per ton, there would be no margin for expense, freight and profit.

It therefore appeared that unless the cost of production of the Napunti ribbons could be greatly reduced there would not be much chance of utilising the fibre for paper-making.

Urena lobata.

Gambia.—A sample of this fibre received from the Gambia was soft, of a greenish-grey colour, well cleaned and prepared, fine, lustrous, of good strength and about three feet long. On chemical examination it gave the following results:—

	Per cent.
Moisture	10·9
Ash	0·4
α-Hydrolysis (loss)	9·8
β-Hydrolysis (loss)	16·3
Acid purification (loss)	1·3
Cellulose	74·6

In chemical composition and behaviour the fibre was superior to a specimen of "medium quality" Indian jute with which it was compared. It was only half the usual length of jute, but would nevertheless be readily saleable as a jute substitute at £17 per ton (with "medium" jute at £15–£17 per ton). It was suggested that a consignment of the well-prepared product should be forwarded for trial sale.

RUBBERS FROM TRINIDAD.

A COLLECTION of rubbers prepared in Trinidad from trees growing on lands belonging to the Botanical Department or on private estates was recently forwarded for examination to the Imperial Institute. The collection included samples of Para, Castilloa, Funtumia and Landolphia rubbers, according to the following list, which also gives notes supplied regarding them:—

No. 1.	Para biscuit from tree A.	Natural coagulation.
No. 2.	" " " " B.	" "
No. 3.	" " " trees A and B (mixed).	" "
No. 4.	" " " " A.	" "
No. 5.	" " " " B.	" "
No. 6.	" " " " A.	" "
No. 7.	" ball " " A.	Wound out of cuts daily after taking flowing milk.
No. 8.	" ball " " B.	
No. 9.	" scrap, trees A and B.	

The two trees which furnished the above specimens are stated to be from 30 to 35 years old and are about the same size. Both have been determined to be *Hevea brasiliensis*, but it is thought in Trinidad that the rubber they yield is of different quality.

No. 10. Castilloa rubber. Cake. Washed in three waters, skimmed and allowed to coagulate in glass saucer.

No. 11. Castilloa rubber. Cake. Latex washed through strainer with 12 volumes of water and left in vessel to coagulate. It was taken as a cake from surface 6 days afterwards and pressed.

No. 12. Castilloa scrap. Collected from trees which furnished Nos. 10 and 11.

These specimens were prepared from Castilloa trees which were planted to fill up the gaps in a permanent plot of *Hevea brasiliensis*. The trees are $7\frac{1}{2}$ years old, but are of small size owing to the *Hevea* trees outgrowing them.

No. 13. *Funtumia elastica* rubber. Coagulated by boiling. The rubber was collected from $7\frac{1}{2}$ year old trees.

No. 14. *Landolphia Kirkii* rubber. Wound out of cuts a few seconds after cutting.

The foregoing specimens, Nos. 1 to 14, were all prepared from trees growing on lands belonging to the Botanical Department.

Nos. 15 and 16. Castilloa block and scrap from trees 17 years old.

Nos. 17 and 18. Castilloa sheet and scrap.

Nos. 19 and 20. " " " "

No. 21. " " from trees 6 years old.

Nos. 22 and 23. " " and scrap.

These specimens, Nos. 15 to 23, represent the rubber which is being produced at the present time on private estates in Trinidad, and for which, it is stated, prices of from 3*s.* to 4*s.* 3*d.* per lb. are being obtained.

No. 24. Venezuelan balata (*Mimusops globosa*).

No. 25. Venezuelan *Loranthus* rubber.

The results of the chemical examination and commercial valuation of these samples are given in the following account.

PARA RUBBER (*Hevea brasiliensis*).

Nos. 1 and 4. "Para rubber. Tree A. Age 30–35 years. Natural coagulation." Weight 4 oz.

Two thin biscuits, from 5 to 6 inches in diameter and $\frac{1}{8}$ inch thick, with rather rough surface.

The rubber was light reddish-brown, clean, well prepared and free from stickiness; its physical properties were very satisfactory.

The following results were obtained on analysis :—

	Rubber as received. Per cent.	Composition of dry rubber. Per cent.
Moisture	2·0	—
Caoutchouc	93·0	94·9 *
Resin	3·1	3·2
Proteids	1·6	1·6
Ash	0·3	0·3

* Soluble in chloroform 93·6 per cent. ; insoluble in chloroform 1·3 per cent.

The rubber was valued at 5*s.* 1*d.* per lb. in London, with fine hard Para from South America quoted at 4*s.* 7*d.* per lb. and Para biscuits from Ceylon and the Federated Malay States at 5*s.* 1*d.* to 5*s.* 7½*d.* per lb.

Sample No. 6, also derived from tree A, was a very thin biscuit of pale yellow rubber, weighing about ½ oz. It exhibited good elasticity and tenacity and was quite equal in quality to samples 1 and 4; it was, however, too small for separate examination.

Nos. 2 and 5. "Para rubber. Tree B. Age 30–35 years. Natural coagulation." Weight 7 oz.

Two biscuits of rubber; one 6 inches in diameter and nearly $\frac{5}{8}$ inch thick, the other 4 inches in diameter and from $\frac{1}{8}$ to $\frac{1}{4}$ inch thick.

The rubber was light coloured, clean, well prepared, and free from stickiness, but was not quite so strong as the rubber from tree A.

The results of the analysis were as follows :—

	Rubber as received. Per cent.	Composition of dry rubber. Per cent.
Moisture	3·7	—
Caoutchouc	89·3	92·7 *
Resin	3·6	3·7
Proteids	2·6	2·7
Ash	0·8	0·8

* Soluble in chloroform 87·4 per cent. ; insoluble in chloroform 5·3 per cent.

The rubber was valued at 4*s.* 11*d.* per lb. in London.

These samples of rubber from tree B were slightly inferior in physical properties to the specimens prepared from tree A, and the value assigned to the rubber is correspondingly lower. The only noteworthy difference in the composition of the rubber from these two trees is that the product from tree B contains a much higher percentage of "insoluble caoutchouc" than that from tree A.

No. 3. "Para rubber. Latex from trees A and B mixed. Natural coagulation." Weight 4½ oz.

The specimen was a thick biscuit about 5 inches in diameter and from ⅜ to ½ inch thick. The rubber was dark coloured externally but white within, rather porous and moist, and possessed a slight disagreeable odour; it exhibited good elasticity and tenacity. It was not submitted to chemical examination.

Owing to the thickness of the biscuit the rubber had not thoroughly dried, and its moist character adversely affected its market value. The specimen was valued at 4*s.* 3*d.* per lb. in London.

CASTILLOA RUBBER (*Castilloa elastica*).

No. 10. "Castilloa rubber from trees 7½ years planted." Weight 6 oz.

A thick cake of rubber, 5 inches in diameter and from ⅛ to ½ inch thick.

The rubber was almost black externally, but greenish-white within when freshly cut; it was clean, slightly sticky, and exhibited very poor elasticity and tenacity.

The results of the analysis were as follows:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	2·5	—
Caoutchouc	46·4	47·5
Resin	50·6	52·0
Proteids	0·5	0·5
Insoluble matter	nil.	nil.
Ash	0·24	0·25

This sample of rubber is of inferior quality on account of the

very high percentage of resin present. It was valued at 2*s.* per lb. in London.

No. 11. "Castilloa rubber from trees $7\frac{1}{2}$ years planted." Weight $8\frac{1}{2}$ oz.

A thick cake of rubber, 6 inches in diameter and 1 inch thick. The rubber was almost black externally but lighter within, clean and slightly sticky; its physical properties were not very satisfactory, although it was superior in this respect to the preceding specimen No. 10.

The rubber had the following composition:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	2·5	—
Caoutchouc	57·6	59·1
Resin	36·0	36·9
Proteids	1·0	1·0
Insoluble matter	2·9	3·0
Ash	2·4	2·5

This sample contains less resin than No. 10, but the amount of this constituent is still very much greater than is admissible in rubber of good quality. It was valued at 3*s.* per lb. in London. The scrap rubber, sample No. 12, corresponding to Nos. 10 and 11, was valued at 2*s.* 10*d.* per lb.

No. 15. "Castilloa block from trees 17 years old." Weight $2\frac{1}{4}$ lb.

An oblong piece of rubber, about 2 feet long, from 3 to 4 inches wide and 1 inch thick.

The rubber was brown externally but lighter within; it was clean, free from stickiness, and exhibited fair elasticity and tenacity.

The following results were obtained on analysis:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	8·0	—
Caoutchouc	69·2	75·2
Resin	21·2	23·0
Proteids	0·6	0·7
Insoluble matter	1·0	1·1
Ash	1·99	2·15

This sample of Castilloa rubber is of better quality than Nos. 10 and 11, but the amount of resin is still excessive. It was valued at 3*s.* 6*d.* per lb. in London. The scrap rubber from the same source, sample No. 16, was valued at 2*s.* 1*d.* per lb.

No. 17. "Castilloa sheet." Weight 1 lb.

A large sheet of rubber, 12 × 14 inches, and from $\frac{1}{16}$ to $\frac{1}{8}$ inch thick.

The rubber was clean, pale yellow, and free from stickiness; it was, however, weak and tore readily.

The rubber had the following composition:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	0·8	—
Caoutchouc	76·1	76·7
Resin	21·5	21·7
Proteids	0·5	0·5
Insoluble matter	1·1	1·1
Ash	0·71	0·72

This sample is very similar in composition to No. 15, but is a little weaker. It was valued at 3*s.* 5*d.* per lb. in London. The corresponding scrap rubber was valued at 3*s.* per lb.

No. 19. "Castilloa sheet." Weight 5½ oz.

Two thin sheets of clean rubber, pale colour, sticky. The rubber was very weak and tore readily.

The following results were obtained on analysis:—

	Per cent.
Moisture	0·1
Caoutchouc	60·9
Resin	37·2
Proteids	0·4
Insoluble matter	1·4
Ash	0·37

This sample is of inferior quality on account of the high percentage of resin. In composition it agrees well with sample No. 11. The scrap rubber, No. 20, contained a little less resin than

the sheet, viz. 32·4 per cent. The sheet rubber was valued at 2*s*. 3*d*. per lb., and the corresponding scrap rubber in ball form at 3*s*. per lb. in London.

No. 21. "Castilloa sheet." Weight 5 oz.

Three small irregular cakes of clean black rubber, which exhibited fair elasticity and tenacity, but tore when stretched.

The rubber had the following composition :—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	1·0	—
Caoutchouc	75·4	76·1
Resin	20·4	20·6
Proteids	0·6	0·6
Insoluble matter	2·6	2·7
Ash	2·17	2·19

This sample corresponds in composition and quality with Nos. 15 and 17. It was valued at 3*s*. 6*d*. per lb. in London.

No. 22. "Castilloa sheet." Weight 15 oz.

Two thin sheets of rubber about 10 inches square. The rubber was clean, well prepared, pale in colour and free from stickiness; it exhibited good elasticity and tenacity, being much superior in these respects to all the other samples.

The results of the analysis were as follows :—

	Per cent.
Moisture	0·1
Caoutchouc	83·0
Resin	15·6
Proteids	0·4
Insoluble matter	0·9
Ash	0·51

This sample of Castilloa rubber contains less resin than any of the other specimens. It was very well prepared and is certainly the best sample of Castilloa rubber in the series. It was valued at 4*s*. 6*d*. per lb. in London, the corresponding scrap rubber, No. 23, being valued at 2*s*. 7*d*. per lb.

FUNTUMIA RUBBER (*Funtumia elastica*).

No. 13. "*Funtumia elastica.* Ire rubber; coagulated by boiling." Weight $1\frac{3}{4}$ oz.

A small oval piece of black rubber, clean, well prepared and free from stickiness; it exhibited fair elasticity and tenacity.

The following results were obtained on analysis:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	3·2	—
Caoutchouc	84·8	87·6
Resin	8·7	9·0
Proteids	2·6	2·7
Insoluble matter	0·7	0·7
Ash	0·71	0·73

This rubber is of very fair quality, although it is not very strong and the percentage of resin is a little high. The specimen was valued at 3*s.* 8*d.* per lb. in London.

RUBBER OF *Landolphia Kirkii.*

No. 14. "Landolphia rubber." Weight $\frac{1}{2}$ oz.

A very small ball of reddish-brown rubber, which was white internally when freshly cut. The rubber was clean, of good quality, and exhibited very satisfactory physical properties.

The sample was too small for chemical examination, or commercial valuation.

The botanical specimens of the vine which furnished this rubber have been identified at Kew as *Landolphia Kirkii*, Dyer.

BALATA (*Mimusops globosa*).

No. 24. "Balata from Venezuela (*Mimusops globosa*)." Weight $2\frac{1}{4}$ lb.

A block of balata measuring about 8 inches × $3\frac{1}{2}$ inches × $3\frac{1}{2}$ inches. It was dark grey in colour, fairly clean, hard and very tenacious.

The balata had the following composition:—

	Per cent.
Moisture	1·8
Gutta	45·7
Resin	44·2
Proteids	3·0
Insoluble matter	5·3
Ash	1·28

This sample of balata is of good quality, agreeing well in composition with the average figures for commercial consignments. It was valued at 1*s.* 7½*d.* per lb. in London.

LORANTHUS RUBBER

No. 25. "Venezuelan Loranthus rubber." Weight 1 oz.

The sample consisted of two pieces of rubber: (1) a thin strip 1 inch × 3 inches, with smooth surface, and (2) a thin flat cake with rough surface.

The rubber was fairly tenacious but exhibited little elasticity.

The following results were obtained on analysis:—

	Rubber as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	4·7	—
Caoutchouc	54·4	57·1
Resin	17·7	18·6
Proteids	4·1	4·3
Insoluble matter	19·1	20·0
Ash	1·70	1·78

This Loranthus rubber is of inferior quality on account of the high percentage of resin and the large amount of insoluble matter present. The sample was too small for trustworthy valuation.

Conclusions.

Para Rubber.—The investigation has shown that the samples of Para rubber prepared in Trinidad are of good quality and would realise very satisfactory prices in the market. From the specimens submitted to the Imperial Institute it would appear

that the rubber from tree A is a little better than that yielded by tree B, although the difference is only slight.

Castilloa Rubber.—The two samples of Castilloa rubber, Nos. 10 and 11, from trees growing on land belonging to the Botanical Department, contain exceptionally high percentages of resin (viz. 52 and 37 per cent. respectively) for the product of $7\frac{1}{2}$ year old trees. It may, however, be noted that the trees in question are stated to be of small growth owing to the fact that they were planted along with Para trees and the latter had outgrown them.

The other samples of Castilloa rubber were derived from private estates in Trinidad. Of these No. 19 contained 37·2 per cent. of resin, thus agreeing in composition with No. 11, whereas in the other specimens, Nos. 15, 17, 21, and 22, the amounts of resin were much less, ranging from 15·6 to 23 per cent. Even these latter percentages are much higher than those usually recorded for Castilloa rubber from mature trees.

The valuations of the sheet Castilloa rubbers vary from 2*s.* to 4*s.* 6*d.* per lb. and those of the "scrap" from 2*s.* 1*d.* to 3*s.* 0*d.* per lb. It may be noted that in the case of the specimens Nos. 19 and 20 the scrap rubber in ball form was valued by the brokers at more than the corresponding sheet. The latter was exceptionally weak, whereas the ball of scrap rubber appeared to be much stronger and contained a little less resin.

Funtumia Rubber.—The single specimen of this rubber which was submitted was of very fair quality.

TIMBERS FROM SOUTHERN NIGERIA.

THIS collection of timbers was forwarded for examination to the Imperial Institute from Southern Nigeria, at the instance of the Conservator of Forests, and was received through Messrs. Alexander Miller, Brother and Co., of Liverpool, in December 1905.

The native (Benin) names of the trees and the botanical names given in the following statement, were supplied by the Forestry

Department in Southern Nigeria, but those marked * have been added from information given in an article on Southern Nigeria timbers in the *Kew Bulletin* (1908, p. 189). A selection of these timbers has been placed on view in the Southern Nigerian Court (Crown Colonies) of the Franco-British Exhibition.

Mechanical Tests.

The mechanical tests of the timbers were carried out by Professor W. C. Unwin, F.R.S., and Professor W. E. Dalby, Expert Referees on Timbers to the Imperial Institute, who have reported as follows.

When the logs of timber were received it was considered what tests of strength could be made with most advantage. It should be pointed out that the quality of timber varies a good deal with the age of the tree, the time of felling, the condition of seasoning, and the part of the tree from which the logs were cut. On these points no information was available.

The tests were carried out in precisely the same manner as previous tests of Colonial timbers, described in the *Technical Reports and Scientific Papers of the Imperial Institute,* published in 1903. The results of these tests may with advantage be compared with those given there.

The logs were in some cases badly split, so that it was difficult to cut from them test pieces which were quite satisfactory; some of them also contained sap.

The density was obtained by preparing prisms about $4'' \times 4'' \times 6\frac{1}{2}''$. These were carefully measured and weighed, and the heaviness computed. None of the timbers is excessively heavy, and some are light timbers. None of the timbers is heavy enough to sink in water. The heaviest are about the density of oak; several are about the density of red pine.

The transverse strength was determined on bars about $4'' \times 4'' \times 36''$ span, which were loaded at the centre. The coefficient of transverse strength is the value of f in the equation—

$$f=\frac{M}{Z}=\frac{3}{2}\frac{Wl}{bd^2}$$

where W is the breaking load, l the span, b the width, and d

the depth of the bar. The elastic limit is not very definitely marked in the case of timber. It has been taken at the load up to which the deflections were approximately proportioned to the loads.

The strongest timbers, Nos. 3, 7, and 9, are rather stronger than oak, and these have fairly high elastic strength, and a high coefficient of elasticity. The resistance to shearing along the fibres is important in some uses of timber, and, as would be expected, the three timbers named above gave good results in this respect.

On the whole the crushing resistance is the best general index of the strength of timber. None of the timbers had a crushing strength as great as that of oak. Nos. 3, 7, and 9 are again the strongest, having a strength on the average of $3\frac{1}{2}$ tons per square inch, whereas oak has a strength of about $4\frac{1}{2}$ tons per square inch. Red pine has a crushing strength of about $2\frac{1}{2}$ tons per square inch, and several of the timbers fall below this.

The table on page 147 summarises the results of the tests.

For comparison with these results the following figures for certain well-known European timbers may be quoted :—

	Heaviness. Pounds per cubic foot.	Coefficient of transverse strength. Pounds per square inch.	Crushing strength. Pounds per square inch.
Oak . . .	52	12,000	10,000
Elm . . .	34	8,000	10,000
Ash . . .	47	13,000	9,000
Red Pine . .	37	8,300	8,000

The working properties of the timbers have been investigated by Mr. Herbert Stone, F.L.S., Expert Referee to the Imperial Institute, who has determined the behaviour of the woods in the usual wood-working operations, and furnished the following report upon their qualities and technical value. He states that the series of timbers is of interest in many respects, and that it comprises a number of good and useful woods. Few, if any, will be valuable for export, but many are likely to be useful in the Colony.

Mr. Stone draws attention to the bad condition of many of

NATIVE NAME.	Heaviness. Pounds per cubic foot.†	Coefficient of transverse strength. Pounds per sq. inch.‡	Stress at elastic limit. Pounds per sq. inch.‡	Ultimate deflections in transverse tests. Coefficiency of elasticity. Pounds per sq. inch.‡	Load at centre in pounds.	Deflection in inches.	Shearing stress. Pounds per sq. inch.‖	Crushing stress. Tons per sq. inch.†
1. Odonomokuku . . .	43·8	6,046	3,938	1,155,000	6,000 6,000	·464 ·529	703	1·43
2. Obobo-Nufwa . . .	50·8	7,296	4,377	1,073,000	8,000 8,000	·809 ·444	907	1·70
3. Ukpe-Nikwi	71·6	13,010	8,296	1,811,000	13,000 14,000	·422 ·449	1,182	3·21
4. Agba	32·9	4,935	2,263	842,000	5,000 5,000	·383 ·397	594	1·38
5. Ozikiba (Nikiba) . .	45·6	10,334	6,964	1,511,000	11,000 12,000	·425 ·458	927	3·21
7. Okan	58·3	12,775	7,743	1,814,000	13,000 16,000	·574 ·701	1,447	3·25
8. Ainyasan	50·0	10,146	5,393	1,827,000	12,000 10,000	·528 ·310	922	2·97
9. Ogwega	68·1	16,170	9,147	2,075,000	20,000 19,000	·992 ·817	1,117	3·96
10. Obobo-Nikwi * . . .	48·3	6,968	4,355	1,344,000	7,000	·236	879	2·71
11. Apopo (Anamamilla) .	32·4	6,164	2,751	919,200	6,000 3,000	·342 ·166	583	1·91
12. Ikpwabobo	42·1	6,319	3,315	985,500	7,000 7,000	·438 ·539	895	1·92
13. Ogwango	32·0	6,254	3,278	1,233,000	7,000 7,000	·541 ·340	757	1·82
14. Ekpagoy	55·6	8,684	3,107	1,396,000	9,000	·402	773	2·40
15. Ochwen *	49·3	8,949	5,418	1,488,000	10,000 11,000	·544 ·722	977	2·40
16. Akpwania	58·1	10,853	7,313	1,628,000	15,000 10,000	·537 ·374	1,037	2·76
20. (Not known)	51·1	8,072	5,518	1,490,000	9,000 9,000	·315 ·341	607	2·73
21. Agoyn	41·4	5,209	2,080	891,500	5,000 6,000	·327 ·495	422	1·24
22. Okoko	51·3	10,625	4,589	1,976,000	12,000 12,000	·584 ·752	919	2·82
23. Ekhimi	53·1	8,951	4,693	1,248,000	10,000 10,000	·502 ·540	894	2·57
25. Owegwi	55·7	9,690	5,284	1,420,000	10,000 10,000	·515 ·514	581	2·57
26. Uwowe	52·0	8,973	6,538	1,399,000	10,000 10,000	·386 ·335	1,030	2·71

* These logs were badly split.

† Mean of two tests, except in the case of No. 1, of which only one test of heaviness and one of crushing strength were made.

‡ Mean of two tests, except in the cases of Nos. 10 and 25, of which only one test was made.

‖ Mean of two tests, except in the case of No. 20, of which only one shearing test was made.

the timbers, and points out the desirability of sending only sound logs for examination, as good woods may be condemned undeservedly when represented by unsound specimens.

Working Tests.

No. 1. ODONOMOKUKU, *Santiriopsis Klaineana.** "A large tree, somewhat resembling No. 12."

The wood is light-brown, with dull and lustrous vertical bands alternately, and has a light-coloured, lustrous silver-grain, which is visible more by reflection than colour. In structure it resembles Panama mahogany. The specimen was badly cracked, in fact shattered.

The wood saws about as hard as oak, giving off a pungent smell like an Euphorbiaceous wood; planes badly, being cross-grained and woolly; polishes fairly well; takes nails well; is strong and cleaves smoothly with a slanting or twisted, shining surface; its fracture is "flat-fibrous." It is a wood of poor quality, not ornamental, and of no use for export.

No. 2. OBOBO-NUFWA, *Heckeldora* (Guarea) sp.*. "A large tree, so-called 'White Cedar.' Shipped as mahogany."

The wood is light-red in colour throughout, with some lustre. The silver-grain is scarcely perceptible without a lens, and is only sufficient to show as a fine hatching, which gives a soft appearance to the wood. The structure resembles that of Dysoxylon, and the general appearance is not unlike it. The specimen was shattered.

The wood saws like elm, with a spicy aroma; planes crisply, but is cross-grained; takes a good polish; takes nails fairly well; is fissile and cleaves with a shining surface. It is a useful, ornamental wood, which may possibly be of value for export, for such purposes for which cheap mahogany is now used.

No. 3. UKPE-NIKWI (black). "A large hardwood tree, used for beams and rafters by the Bini."

The colour of this timber varies from reddish-brown to grey, and the wood has conspicuous, large-chambered pores containing a white deposit, which gives it a speckled appearance. These white pores are prominent on a transverse section, and frequently unite to form strings of as many as eight pores in contact. The

rays, which are imperceptible as silver-grain, are very fine and numerous. The specimen was shattered.

The wood saws rather harder than oak, and exudes a milky juice from the end of the log, as the saw approaches the end of the cut; it planes smooth, but is hard; takes a fairly good finish when polished; splits when nailed; cleaves with a dull surface; is strong, and breaks with a fibrous fracture.

It is not an ornamental wood, but it will be found useful in large pieces. It is of no value for export.

No. 4. AGBA. "A large tree, fine straight stem, clear of branches 70 to 80 feet up. So-called white mahogany."

The wood is yellowish-white to reddish-white or pinkish, and is quite uniform, the colour being chiefly due to the numerous fine pores. The silver-grain is almost colourless and nearly imperceptible. The structure is similar to that of mahogany. The specimen was badly shaken (*i. e.* cracked).

The wood saws as hard as elm, with an agreeable smell; it planes easily and sweetly; polishes fairly well but requires a good deal of labour to make a good surface; takes nails fairly well, and is hard to split; cleaves with a smooth shining surface and slightly twisted grain. It is a weak timber, the fracture being short.

It is not an ornamental wood, but doubtless will be very useful for Colonial work, though not valuable for export.

No. 5. OZIKIBA (NIKIBA). "A fairly large tree used for rafters and beams by the Bini, and said to be a durable wood."

The colour of the wood is a beautiful, pale vermilion. It has but little lustre, and is marred by occasional blackish streaks. The silver-grain is only perceptible as minute glistening points. The pores are small and scattered between the numerous, closely-arranged rays. The specimen was shattered.

The timber, which had 4 inches of yellow sapwood, saws as hard as oak, and a copious milky juice pours out of the end of the grain as in No. 3, but more abundantly. In sawing a plank 18 inches long by 5 inches wide, about one-eighth of a fluid ounce ran out, commencing to exude from the wood when the saw was still 6 inches from the end of the cut. The wood planes crisply and sweetly; polishes well; takes

nails badly, being fissile; cleaves with a smooth, bright surface. It is a weak timber, very brittle and splintery, and breaks with a short "biscuit" fracture. The wood is both ornamental and useful, and if sound would be suitable for export.

No. 7. OKAN, *Piptadenia* sp. "A large very hard wood tree. Shipped as greenheart, but is not the true greenheart."

The colour of the wood is brownish golden-yellow, the brown being due to the extremely conspicuous pores, and the golden-yellow to the wood fibres. The pores contain readily-visible drops of black resin. In its metallic lustre, and in its structure and general appearance, this wood resembles Jak-wood (Artocarpus), but the annual rings are more boldly marked. The specimen was badly shaken; it was cut from a large tree with 3 inches of brownish sapwood.

The wood saws as hard as oak, and exudes a milky fluid, as in Nos. 3 and 5; it has an objectionable pig-like odour; planes badly; is cross-grained and stringy; polishes very indifferently; will not take nails; cleaves easily, with a grooved, uneven, twisted grain and bright surface. It is a weak and brittle wood, breaking suddenly with a "biscuit" fracture.

The wood may be considered ornamental, being of the same colour as *Sarcocephalus*, and is possibly worth exporting.

No. 8. AINYASAN. "A medium tree, shipped as satin-wood."

The wood is light-brown in colour, with alternating light and dark bands, and has considerable lustre. The silver-grain is perceptible in certain lights, as a fine, whitish shading. The structure of the wood resembles that of Chlorophora (fustic). The specimen was shattered.

The timber saws as hard as box-wood; it planes indifferently, being rather tough and cross-grained; takes a good polish; will not take nails, and cleaves fairly evenly with a twisted grain.

It is not ornamental, but will be found a useful wood in the Colony. It is of no value for export.

No. 9. OGWEGA, *Dialium guineense.* (?) "A large tree, sold as a species of mahogany, called furniture wood."

The wood has a striped appearance, exhibiting dark-brown and blackish bands of varying tone. The sapwood is light-brown, and is sharply defined from the heartwood. The silver-

grain is greyish, but inconspicuous, being only sufficient to give the surface of the wood a speckled, or shaded appearance. The structure suggests that of Lophira (African oak), the concentric rings of soft tissue being extremely numerous, close and undulating. The specimen was shattered, almost comminuted.

The timber saws as hard as oak, with an unpleasant smell; it planes easily, but is rather brittle and cross-grained; polishes well; will not take nails as it is very fissile. Much of the specimen was rotten, and on this account the fracture could not be noted.

It is a rather ornamental wood, and doubtless would be useful in the Colony, but it is unsuitable for export. The specimen being unsound, the tests are more or less untrustworthy.

No. 10. OBOBO-NIKWI (black), *Heckeldora* sp. nov. (Unwin). "A large so-called 'black' cedar-tree (see No. 2) said to be the male of the 'white' cedar."

The colour of the wood is reddish and uniform. It has but little lustre, and the silver-grain is whitish and inconspicuous, though readily visible. In structure it resembles No. 9, and is possibly related to it. The specimen was shattered.

The timber saws like oak; it planes badly, being cross-grained and woolly; polishes with a fairly good finish; will not take nails; is fissile, cleaving easily with a strait grain and dull surface. It is not a strong wood, and the fracture is short and "flat-fibrous."

It is not very ornamental, but will probably be useful in the Colony, although not suitable for export.

No. 11. APOPO (ANAMAMILLA), *Pseudocedrela* sp. "A large tree. A so-called African walnut."

The colour of the wood is greyish-brown, with narrow black lines and dark pores, which gives the surface a "pepper-and-salt" appearance. The black lines appear to be the boundaries of the year's growth, where an excessive deposit of black resin occurs. This resin appears in the form of minute, but readily visible, drops in the pores generally. The structure is something like that of No. 4. The specimen was shattered.

The wood saws as hard as elm, and planes badly, being cross-grained and woolly; it polishes fairly well; will not take nails; rather tough; cleaves with a twisted grain and shining

surface. It is weak and brittle, and breaks with a "biscuit" fracture.

It is not an ornamental wood, but it will be useful in the Colony. It is of no value for export.

No. 12. IKPWABOBO, *Entandophragma candollei.* The wood resembles African mahogany in all respects, and would pass as such. The specimen was in fair condition. The wood saws as hard as elm, with an unpleasant, spicy smell; it planes fairly well, but is inclined to be cross-grained; takes nails badly; fissile, and cleaves with a smooth shining surface; takes an excellent finish when polished. It is weak and brittle, and the fracture is biscuit-like and splintery.

The wood is both ornamental and useful, and will be valuable for export. This wood is the best of the series.

No. 13. OGWANGO, *Khaya senegalensis.* The specimen was shaken. The wood saws as hard as oak; it planes badly, being cross-grained and woolly. It can be made to take a fairly good finish when polished, but a good deal of preparation is necessary. The wood is tough and strong; twisted in the grain, and cleaves with difficulty; it will not take nails.

It is an ornamental and useful wood, and will be valuable for export. If this wood is the African mahogany of commerce (which appears doubtful), the better qualities will of course command a market. The present sample is only equal to the inferior kinds of mahogany known under the name of "baywood," which it resembles in all respects.

No. 14. EKPAGOY, *Berlinia acuminata.* "A fairly large tree, fairly straight bole, liable to branch low down. Hard white wood."

The colour of the wood is light-red, marred by occasional dark streaks. The silver-grain is almost imperceptible, and the grain is coarse and sinuous. The pores have large chambers visible to the naked eye, and are bordered by lighter coloured soft tissue. The structure is that of a leguminous wood, somewhat resembling Mora. The specimen was badly shaken.

The wood saws as hard as elm, with an unpleasant cheese-like odour; it planes badly, being cross-grained and stringy; polishes rather badly; takes nails indifferently, and cleaves easily, with a dull, rugged, grooved surface and twisted grain. It is a weak wood, and the fracture is "short fibrous."

The timber may be described as slightly ornamental. It will no doubt be useful in the Colony, but is no good for export.

No. 15. OCHWEN, *Ricinodendron africanus.*

The colour and appearance of the wood are something like those of English elm. The grain is coarse, the silver-grain imperceptible, and the surface rather lustrous. In cross-section the pores are very conspicuous, being surrounded by a readily visible border of lighter coloured soft tissue. The specimen was shattered.

The wood saws as hard as boxwood; planes fairly well, but is inclined to be cross-grained; polishes fairly well; will not take nails; is fissile, and cleaves easily, with twisted grain and ragged surface.

It is not an ornamental wood; it will be useful in the Colony, but is unsuitable for export.

No. 16. AKPWANIA. "A large tree."

The colour of the wood is greyish-brown. The grain is moderately coarse, and the silver-grain inconspicuous. In the cross-section, the readily visible pores are joined up by lighter coloured soft tissue to long, oblique strings, which are scarcely interrupted by the yearly growth. The specimen was badly shaken.

The wood saws harder than oak, with a pungent smell and exudes a milky juice; it is tough and hard to plane; polishes indifferently; will not take nails; is rather fissile, and cleaves with a dull, flat, smooth surface and somewhat twisted grain. It is weak, and breaks with an uneven "biscuit" fracture.

The wood is not ornamental and is of doubtful utility. It would be useless for export purposes.

No. 20. "Wing Seed Tree (native name not known)."

The colour of the wood is yellowish-brown, in patches and streaks. The grain is coarse, and the silver-grain imperceptible. The structure is not unlike that of No. 15, but the pores on a cross-section are much less conspicuous. The specimen was doubtfully sound.

The wood saws as hard as elm, and exudes a milky juice; it has no smell; planes sweetly and cleanly; takes a fairly good polish; will not take nails; is rather fissile, and cleaves easily with a somewhat twisted grain and bright surface. It is a weak

wood, and breaks with a "biscuit" fracture, but no doubt it is stronger when sound.

The wood is not ornamental, and is of doubtful utility. It is useless for export.

No. 21. AGOYN. "A large tree. Wood used for making doors."

The colour of the wood is a silver grey with a yellow tinge. It is prettily marked, like English elm or acacia (*Robinia*), which latter wood it strongly resembles. The specimen was unsound, the centre being rotten and mouldy. The condition of the specimen prevented proper tests being made.

The wood saws as hard as elm, with an unpleasant pungent odour. It polishes badly.

It is not ornamental, but possibly will be useful in the Colony. It is useless for export.

No. 22. OKOKO, *Sterculia* sp. (?) "A large tree. The wood is used for making planks."

The wood shows fine golden-yellow and white streaks. The grain is fine, and the silver-grain white and conspicuous. The structure resembles that of *Plagianthus*. The specimen was shattered.

The wood saws something like elm, but with a peculiar fish-like odour, recalling that of euphorbiaceous wood ; it planes tolerably ; is tough ; takes an ordinary polish fairly well ; tends to split with nails, and cleaves rather easily with a twisted grain.

The wood is not ornamental, and has no export value, but should prove a useful wood in the Colony.

No. 23. EKHIMI, *Piptadenia africana*. "A fairly large tree, sometimes called the smaller Okan ; used for planks."

The colour of the wood is pale-yellow. The grain is coarse and the silver-grain imperceptible. The structure resembles that of No. 15, to which it is probably related. The specimen was in good condition.

The wood saws hard with a pungent smell like that of No. 16, and exudes a milky juice ; it planes easily ; is cross-grained but soft ; polishes fairly well ; is fissile, and will not take nails ; it cleaves easily and straight, but with a ragged surface. The wood is brittle, and breaks with a short "biscuit" fracture.

It is of poor appearance, and of doubtful value for export, but it will be useful locally.

No. 25. OWEGWI. "A large tree. Wood used for making planks."

The colour of the wood is uniform brownish-red. The grain is wavy and rather fine, and the silver-grain imperceptible. The structure has a slight resemblance to that of Robinia, though the wood is not like it in any other respect. The specimen was shattered and worm-eaten.

The wood saws hard, with a smell something like that of No. 22. It is tough to plane; polishes badly, and cleaves with a shining surface. The wood is brittle and breaks with a short "biscuit" fracture.

It is not an ornamental wood, and though of no value for export, would be useful in the Colony.

No. 26. UWOWE. "A medium tree. Wood used for making doors."

This wood might pass for the well-known Indian "lebbek" (*Albizzia Lebbek*). It is a coarse-pored, cross-grained walnut-coloured leguminous wood, with the structure of Albizzia. The specimen was in good condition.

The wood saws exceedingly hard, giving off an unpleasant odour; it planes badly, being brittle and cross-grained; it is difficult to smooth, and consequently very troublesome to polish. The wood is fissile, splitting when nailed, and cleaves very easily with a smooth surface.

This is a somewhat ornamental timber, and may possibly find a market in Europe, though its physical weakness would be against it.

TIN ORES FROM THE FEDERATED MALAY STATES.

IN November 1906 a number of samples of tin ore from deposits in the limestone hills at Sungii Raia, Lane Range, Kinta, Federated Malay States, were received at the Imperial Institute for examination.

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Sample No. 4 represented a deposit in its natural state. It consisted of ferruginous material containing tinstone with small amounts of magnetite and corundum. On analysis it gave 57·77 per cent. of tin oxide (SnO_2). Sample No. 5 was stated to be hand-picked. It consisted of similar material with rounded fragments of corundum and ferruginous conglomerate. It contained 40·12 per cent. of tin oxide (SnO_2) and 25·65 per cent. of alumina.

Sample No. 1 was stated to consist of the washed ore after the removal of the "stuff" or large material. It consisted of a dark reddish sand, the principal constituents of which were tinstone, corundum, quartz, hæmatite, magnetite and rutile. On analysis it yielded 65·84 per cent. of tin oxide (SnO_2) and a small amount (0·14 per cent.) of rare earths. This sample does not appear to have been well concentrated, and it would be improved by separation of the magnetite and fine crushing and washing. The amount of rare earths is too small to be of commercial importance. Sample No. 2 was the "stuff" or large material removed from No. 1. It consisted of soft material, similar to kaolin, containing small pieces of quartz and hæmatite, and carried tin. It appeared to be the result of the decomposition of a felspathic rock and was of no commercial value.

Sample No. 3 was stated to be "small tinstone" from a different locality in the same range. It consisted mainly of small pieces of colourless or occasionally dark-blue corundum, and contained 2·08 per cent. of tin oxide (SnO_2) and 86·40 per cent. of alumina. It was of more value for the corundum than for the tinstone present. An article on the commercial utilisation of corundum from Perak appeared in this *Bulletin* (1904, **2.** 229), while a general account of the occurrence and uses of corundum will be found in a later issue (1906, **4.** 238).

As it appeared probable that these deposits resulted from the disintegration of lodes of tinstone, it was advised that a careful search should be made in order to determine whether this was the case. This recommendation was carried out, with the result that a lode of apparently valuable character was discovered. Samples from this were forwarded to the Imperial Institute for examination. Nos. 1–5 were described as "samples taken from the lode." They consisted of crystalline limestone containing a

considerable amount of tinstone with indications of the oxidised products of copper ore. Of these samples No. 2, which appeared to be of a representative character, was analysed and showed 32·22 per cent. of metallic tin and 0·12 per cent. of metallic copper, constituting a valuable tin ore. All these five samples are rich in tin, containing on an average at least 30 per cent. of the metal, so that they would undoubtedly pay well to work. The ore is present in fairly coarse lumps and crystals, and the only material associated with it is crystalline limestone, which can be readily separated by crushing and washing.

Samples Nos. 6–8, described as taken from the cap of the lode, consisted of ferruginous and arsenical copper ores with tinstone. No. 6 contained 7·37 per cent. of metallic tin, 10·80 per cent. of metallic copper, 1·63 per cent. of zinc, and 12·47 per cent. of arsenic. Some tinstone was present in all three samples.

Samples 9 to 19 were stated to be taken from various parts of the limestone range. No. 18 was a hydrated iron ore, but the remainder were limestones. Some of these (especially Nos. 10 to 16) contained a considerable amount of gritty and earthy impurity, whereas the others were fairly pure and could be used as a source of lime. No. 15 was practically a pure white marble. None of them when taken alone could be regarded as constituting a cement limestone.

It is not improbable that other similar lodes of tinstone occur in the Kinta limestone in the neighbourhood of the granites, and careful search should be made for them in places where alluvial pipes or other deposits of tinstone gravel are met with.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

PRODUCTION AND UTILISATION OF WATTLE BARK.

THE wattle or mimosa barks of commerce are derived from several species of Acacia indigenous to Australia, whence the

barks have long been exported to Europe for use as tanning materials. The name 'wattle' was bestowed on the acacias in Australia owing to their willow-like habit and from the fact that they were used in the early days of the colony for binding hurdles together, generally to serve the same purposes as the wattles of Europe.

The species most prized for the production of bark are *Acacia pycnantha* (Golden Wattle), *Acacia decurrens*, Willd., *Acacia decurrens*, var. *mollissima* (*Acacia mollissima*, Willd.), Black Wattles, and *Acacia dealbata* (Silver Wattle). Of these the bark of *A. pycnantha* is usually richest in tannin whilst that of *A. dealbata* is poorest. *A. decurrens*, var. *mollissima*, has, however, the advantage of being hardier and giving on the whole a better yield of bark, and consequently wherever, as in Natal, wattle cultivation on a large scale has been attempted, this variety has generally been selected for plantation.

Formerly the supply of wattle bark came almost exclusively from Australia, and especially from South Australia and Tasmania, but in 1880 wattles were introduced into Natal, and within the last ten years or so the plantations of Natal have begun to supply a preponderating share of the material. Similar progress has not been made in Australia, but this is probably partly due to the fact that the Commonwealth exporters have relied principally on natural forests and have not practised cultivation of the wattle tree to the same extent as the Natal growers, though recently increased attention has been given to the formation of wattle plantations in Australia (this *Bulletin*, 1907, **5**. 187).

As already indicated, the black wattle is the species usually selected for planting, and the following information regarding the cultivation of the tree and the preparation of the bark relates more especially to this species.

CULTIVATION.

Although the black wattle will grow in practically any kind of soil, experience has shown that a friable sandy loam, or a sandy soil lying on a clay sub-soil two or three feet below the surface answers best. The roots do not penetrate deeply into the ground, and consequently soil which retains moisture is advantageous for their culture.

The plants are invariably grown from seed, but no special precautions are necessary for the sowing. As a rule, rows about 12 feet apart are prepared, and the seed, mixed with a quantity of sand, is planted about one inch deep and in such a manner that the young trees can eventually be thinned out to 6 feet apart in the rows.

The outer covering of the seeds is extremely hard, and to assist germination the seeds should be specially treated before sowing, as under ordinary circumstances they may remain in the ground for a considerable time without germinating. More rapid germination can be brought about in a number of ways. Perhaps the commonest practice is to cover the seeds with boiling water, in which after cooling they are allowed to soak for about 24 hours, after which they are sown as soon as possible immediately after removal from the water. In Australia the seeds are frequently roasted, but care has to be taken to avoid loss by over-heating. Quite recently excellent results are said to have been obtained in German East Africa by soaking the seeds in concentrated sulphuric acid and keeping the mixture stirred occasionally to prevent caking. After the lapse of four or five hours the seeds are removed and thoroughly washed in running water, when they are ready for setting. It is stated that after this treatment 80 to 90 per cent. of the seeds germinate in a few days.

Indian corn (maize) is frequently grown in the spaces between the young wattle plants, generally two rows of maize between each two rows of wattles, and this serves to provide a return from the plantation whilst the wattles are maturing.

After germination the plant grows quickly, and at an age of only four years it generally attains a height of from 25 to 30 feet. The foliage is luxuriant and affords excellent shade for animals or for low-growing crops. Practically no attention is given to the trees themselves, for if they have been properly distributed pruning is unnecessary and several crops of wattles may be taken off the same soil without rendering it unsuitable for their further cultivation.

One of the most serious enemies of the wattle grower is fire, which sometimes spreads from the surrounding prairie and destroys the plantations unless fire "breaks" have been constructed by ploughing broad strips of land round the plantations.

Several insect pests have also made themselves felt on Natal wattle estates, the chief of these being a bagworm, which destroys the foliage and thus checks growth, and red and white ants, which destroy the roots. Locusts are also a serious trouble in some years in Natal, but with suitable precautions their depredations may to a certain extent be mitigated.

Wattle trees reach their prime in about ten years from the time of sowing, though many trees are marked down as large enough to strip after seven or even five years. The rate of growth varies in different localities and soils, and individual variations in the seed also exert considerable influence. When an area of forest is old enough harvesting of the bark is commenced. In Australia the trees are usually stripped during three or four months of the year (generally September, October, November and December), but in Natal the work is carried on at all seasons, as the barks strip readily except in very dry weather. Nevertheless the period from the beginning of March to the end of April is generally adopted, despite the danger of getting the stripped bark soaked with rain before it can be brought under cover and thus losing part of the tannin.

Attention has been drawn recently to the possibility of variation of the content of tannin being caused by stripping at different times of the year, and this matter is being investigated (this *Bulletin*, 1908, **6**. 86).

After clearing away the dead twigs and leaves at the bottom of the tree an incision is made in the bark either (*a*) 3 or 4 feet above the ground or (*b*) as close to the ground as possible. If the former method is adopted the strip or sheet of bark is pulled off *downwards*, thus obtaining much of the bark from the upper roots which is frequently the richest in tannin. In the second case, by a series of strong jerks a broad strip is pulled off up to the height of the lower branches. Sheet after sheet is thus removed from the trunk until it is quite bare, after which the tree is felled and the stripping completed on the portions lying between the branches. A stripping machine has been invented which, it is claimed, removes the bark close up to the leaves, and higher than can be stripped by hand, and it has been stated that its use would reduce the cost of stripping by at least 25 per cent. In using the machine the wattles pass between two

revolving rollers, thus receiving pressure on two sides, which causes the bark to crack and spring from the complete circle of the stem in two halves.

The long strips of bark are hung over poles in the drying sheds, which are arranged to hold about six tons of fresh bark. Drying should take place in the shade and the operation generally lasts several weeks. Although in some cases artificial heat may be employed for drying, care must be taken to avoid too high a temperature, otherwise a diminution in the tannin content will take place. When dry the bark is taken in bundles to the mill, where it is usually cut into short chips or pieces about two inches long by one inch wide, and then after being packed into sacks it is ready for export.

The stripped wattle tree-trunks are generally cut into six or twelve feet lengths for mining timbers, but their use as a source of wood pulp for paper manufacture (see *Technical Reports and Scientific Papers*, published by the Imperial Institute, p. 314), and more recently the distillation of the wood for the production of acetic acid and wood alcohol, has been suggested in Natal.

As previously stated, the same ground will bear several successive crops of wattle trees without becoming exhausted. In the ordinary way a wattle forest replants itself, and an area once cleared of trees is quickly covered again. The naturally grown seedlings are allowed to grow until they form a thick mass covering the field, when they are thinned out, leaving rows twelve feet apart standing. It is stated that replanting from natural seedlings is no great advantage, as the cost of thinning out is greater than that of starting a fresh plantation.

PRODUCTION OF WATTLE BARK.

Australasia.

South Australia.—The wattle bark of South Australia is almost exclusively derived from the "broad-leaved or golden wattle," *A. pycnantha.* This bark is one of the richest of tanning materials, although recently the eucalyptus "mallet bark" of Australia (this *Bulletin*, 1905, **3.** 69) has been found to overstep it in actual tannin content. It is found chiefly on the Adelaide hills and plains, but in the north of the colony a narrower leaved variety

exists which is of slower growth and yields bark of less value. The broad-leaved wattle bark of South Australia generally contains from 40 to 45 per cent. of tannin, tans very quickly and produces a good light-coloured leather. It is worth about £8 to £9 per ton at present.

New South Wales.—This Colony at one time produced and exported large quantities of wattle bark, but of recent years the export trade has been nearly lost, although the price per ton has risen from £6 in 1890 to £8 at the present date. Most of the bark is "green" or "black" wattle, and contains about 35 to 40 per cent. of tannin. *A. pycnantha* cultivation is practically confined to those parts of the country bordering on South Australia and Victoria.

Victoria.—In Victoria no other crop is regarded as so profitable as wattle, especially for poor soil. Thousands of acres are under cultivation, and Victoria is the greatest producing area of black wattle bark in the Commonwealth.

Tasmania.—This island possesses large natural supplies of black wattle, and at one time was the chief Australasian source of this variety. Owing to indiscriminate destruction of the forests and failure to systematise the planting of fresh trees, Tasmania has lost considerable ground, both in the quantity and value per ton of bark exported.

Queensland and Western Australia.—Among the wattles termed "black," there are several mountain hickories of much less importance than *Acacia decurrens*, although containing from 30 to 35 per cent. of tannin. Chief amongst these is *A. penninervis*, which may become of great commercial importance, especially in Queensland, where it is very abundant. At the present time Queensland produces and exports comparatively little wattle bark.

In the last few years Western Australia has exported greatly increasing quantities of wattle bark, although up till 1902 none at all was produced.

New Zealand.—Wattle plantations in New Zealand for the production of tanning bark occupy an area of about 5,000 acres in the Auckland district. The black wattle is the only variety planted.

The following typical analyses of Australian wattles are taken

from results obtained by Blockley (*Journ. Soc. Chem. Ind.*, 1902, **21.** 159):—

Botanical Source.	Local Name.	Source.	Tannin.*	Non Tannin.	Insoluble.	Moisture.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
A. pycnantha .	Golden wattle, "No. 1, special"	S. Australia .	49·5	9·4	29·9	11·2
A. pycnantha .	Golden wattle, "No. 2, ordinary"	S. Australia .	40·2	9·0	39·6	11·2
A. decurrens, sur. *normalis*	Sydney green wattle	St. Mary's (N.S.W.)	41·4	7·9	39·2	11·5
A. decurrens, var. *leichhardtii*	Green wattle . .	Bateman's Bay (N.S.W.)	38·5	9·1	41·4	11·0
A. decurrens, var. *pauci glandulosa*	Green wattle . .	Bateman's Bay (N.S.W.)	36·1	7·8	44·5	11·6
A. decurrens, var. *mollissima*	Black wattle . .	—	38·3	4·4	46·2	11·1
A. penninervis .	Hickory bark .	Bateman's Bay	37·7	5·2	46·1	11·0
A. binervata . .	Black wattle . .	Cambervarra .	30·2	6·7	52·0	11·1
A. dealbata . .	Silver wattle . .	N.S.W. . .	12·2	4·3	71·9	11·6

* Estimated by the bell-filter method (*Bull. Imp. Inst.*, 1907, **5.** 344).

South Africa.

Natal.—Being known to grow quickly, wattles were first introduced into Natal as a shade tree and wind-break, more especially as a protection for cattle. The value of their barks as tanning agents was not recognised until several years later. Natal wattle is nearly all *A. decurrens*, although the "golden" variety is also grown to a limited extent.

The chief centre of the black wattle cultivation was originally in the Noodsberg district, but at present the greater part is grown round about the Umvati, although wattle plantations are scattered throughout the central portion of the Colony, and largely along the railway from Pietermaritzburg to Greytown. One of the largest wattle estates, the Town Hill plantation, covers over 3,000 acres of hilly uplands near Pietermaritzburg.

At present over 30,000 acres in Natal are planted with black wattle, and it is confidently expected that within the next five years the production will be trebled.

Cape Colony and the Transvaal.—The pronounced success of the cultivation of wattle trees in Natal has caused attempts to be made to place wattle cultivation on a commercial basis in

other South African colonies, notably in Cape Colony and the Transvaal. Several samples of Cape Colony wattle bark have been examined at the Imperial Institute, and found to be rich in tannin and of good quality (this *Bulletin*, 1907, 5. 352).

German East Africa.

The cultivation of *A. decurrens* in German East Africa has already passed the experimental stage, and as early as 1904 samples of bark were obtained, which proved to be of satisfactory quality. The seed used in these plantations was obtained partly from Natal and partly from Australia, but as no special care was taken in its selection, very mixed results have been obtained. There seems to be no doubt, however, that German East Africa is well suited for wattle growing, and that in the near future it will be able to compete with Natal and Australia for the supply of bark.

Experimental cultivation of the black wattle has also been undertaken in British East Africa, but so far nothing is known as to the quality of the bark obtained.

The analyses, on the opposite page, of African wattle barks have been partly carried out in the laboratories of the Imperial Institute. In those marked * the tannin was estimated by the bell-filter method.

India and Ceylon.

Several varieties of wattles have been acclimatised in different parts of India, and in the Ceylon hills *A. decurrens* and *A. dealbata* are now plentiful. Although the barks of these trees are used locally for tanning purposes, no attempt has been made to grow or harvest the bark for export.

MARKETING OF WATTLE BARK.

There has since its introduction always been a good demand for wattle bark in the European tanneries, but for several years previous to its commercial production in Natal, English

Botanical Source.	Local Name or Description.	Source.	*Tannin.*	*Non Tannin.*	Ash.	Moisture.
			Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
A. decurrens †.	Black wattle	Warburg, Natal	35·2	7·3	1·6	11·7
A. decurrens †	Black wattle	Natal	37·8	9·3	1·5	9·5
A. decurrens †	Black wattle	Natal	35·2	10·3	2·8	11·3
A. decurrens †	Black wattle	Natal	39·8	9·9	2·3	9·6
A. decurrens †	Black wattle	Natal	36·8	10·3	2·6	10·4
A. decurrens †	Black wattle (chopped)	Fort Conyngham, Cape Colony	35·4*	12·0	1·8	11·4
A. pycnantha	—	Dept. of Agric., Cape Colony	40·1*	13·0	1·5	10·1
A. saligha	—	Dept. of Agric., Cape Colony	26·4*	12·1	4·0	11·1
A. horrida	"Doornbusch"	Alexandra, Cape Colony	18·3*	8·3	4·5	11·0
A. decurrens	Black wattle (unchopped)	Eastern Conservancy, Cape Colony	44·1*	7·1	1·8	10·9
	Mimosa bark	Big Umgagi	18·0*	7·5	5·3	12·4
A. decurrens	5½ years old	Amani, G.E.A.	50·95	8·54	—	2·95
A. decurrens	5½ years old	Amani, G.E.A.	39·28	6·29	—	4·88
A. decurrens	3½ years old	Amani, G.E.A.	38·12	8·35	—	10·76
A. decurrens	—	Wilhelmstal, G.E.A.	47·32	7·52	—	11·02
A. decurrens	10 years old	Kwai, G.E.A.	44·77	8·04	—	8·75
A. mollissima ‡	5 years old	Amani, G.E.A.	44·91	5·85	—	8·71
A. mollissima ‡	5 years old	Amani, G.E.A.	38·61	7·27	—	10·37
A. mollissima ‡	5 years old	Amani, G.E.A.	46·78	9·43	—	9·62
A. mollissima ‡	7 years old	Kwai, G.E.A.	38·14	13·51	—	8·22
A. mollissima ‡	10 years old	Kwai, G.E.A.	46·39	11·76	—	6·01
A. dealbata	—	Wilhelmstal, G.E.A.	17·42	6·54	—	11·15
A. dealbata	—	Wilhelmstal, G.E.A.	18·51	10·96	—	12·86
A. dealbata	—	Wilhelmstal, G.E.A.	18·48	10·55	—	11·92

† Probably all var. *mollissima*. ‡ = *A. decurrens*, var. *mollissima*.

tanners had begun to revert to older and better known tanning materials, owing to the irregularity of the Australian supply.

The chief consumers of wattle bark are Germany and the United Kingdom, but it is difficult to obtain trustworthy statistics showing the relative amounts imported by each country.

The following table, showing the exports of wattle from Australia up to 1904, is taken from the third edition of Maiden's pamphlet on wattles (Sydney, 1906), the market prices in 1906 being £6 10*s.* to £8 per ton for good bark from *A. decurrens*, and over £8 for South Australian bark from *A. pycnantha*.

Australian Exports.

Year.	New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.
1898 tons	835	2,620	12	8,206	—	5,892
£	3,305	17,478	59	62,132	—	31,017
1899 tons	372	3,097	1	8,953	—	5,187
£	2,040	22,772	5	69,985	—	13,042
1900 tons	463	1,560	—	8,386	—	4,742
£	2,983	11,688	—	63,732	—	29,405
1901 tons	29	2,581	15	7,974	—	4,983
£	211	20,966	300	67,601	—	32,773
1902 tons	184	3,896	15	7,702	—	5,765
£	1,111	32,907	98	68,856	—	40,190
1903 tons	382	3,477	177	6,669	138	4,618
£	2,812	28,576	661	65,062	859	32,843
1904 tons	378	5,122	715	7,205	5,059	4,301
£	3,194	41,316	2,685	59,902	32,876	30,506

Owing to the custom of classing all tanning barks together, it is impossible to provide figures for the last two years from the official Commonwealth trade returns, and it should be pointed out that the figures in the foregoing table probably include interstate trade, as total Australian exports of "Tanning Bark" in 1904 were only 12,599 tons, valued at £93,927. This rose in 1905 to 25,514 tons, valued at £189,699, but the increase was no doubt due to "mallet bark," which has been exported in large quantities in recent years.

South Australia's exports in 1890 were 4,444 tons, valued at £56,006, but in 1904, although rising to 7,205 tons, the total value was only £59,902. This decrease in value is due mainly to a general fall in prices, and not to a decrease in quality.

Tasmanian exports dropped during the same period from 11,008 tons to 4,301 tons. The Victorian exports fell in the same period from 5,659 tons to 5,122 tons. The corresponding figures for Natal, given in the following table, are also taken chiefly from Maiden's pamphlet (*loc. cit.*).

Natal Exports.

Year.	Tons.	Value.	Year.	Tons.	Value.
		£			£
1898	9,427	30,929	1903	12,135	70,581
1899	11,070	57,885	1904	15,819	92,911
1900	8,900	46,479	1905	17,513	102,666
1901	13,771	69,850	1906	15,000	89,443
1902	15,537	74,554			

This shows on the whole a considerable expansion. Recently there has been a decline, for instance, in the price of bark, and though this may be due in part to the competition of other tanning materials, it has been suggested in Natal that the confidence of consumers of Natal bark may have been shaken by the export of "weathered" bark, and also of blue wattle bark, which is poorer in tannin, and to combat this and other difficulties a Union has been formed to provide for a "mark" for standard bark, which will be a guide to buyers.

During the last few years the imports of wattle bark into the two chief European ports of discharge (London and Hamburg) have been as follows (*Natal Agric. Journ.* 1907, **10**. 1138; and *Year Book of the Manchester, Liverpool, and District Tanners' Federation*, 1906):—

Year.	London (including bark in transit)		Hamburg (all sources). From Natal.
	From Natal.	From Australia.	
	Tons.	Tons.	Tons.
1900	7,827	1,642	—
1901	11,634	1,448	—
1902	11,232	2,813	6,000
1903	10,649	2,350	5,250
1904	13,671	3,136	7,950
1905	11,914	2,059	8,100
1906	8,461	—	8,300

In 1906 the United Kingdom's consumption was estimated at 2,500 tons (*loc. cit.*), so that Hamburg probably received about 6,000 tons by transhipment from London. In 1906 the United Kingdom imported roughly about one-third of the world's production of wattle bark.

Russia, Austria, and Belgium all take a fair amount of wattle bark, Russia especially using Natal bark. In 1906, 914 tons were exported to Russia, and as trade improves, it is hoped that more will be taken.

At present the United States takes very little wattle bark, and none is produced there. There are signs, however, that the United States is willing to directly interest itself in the question, although it is probable that few parts of the country, except those in the extreme south, are sufficiently free from frost to make the culture of wattle trees profitable (*U.S. Dept. Agric. Bull.*, No. 51, Part IV). It is worth noting, however, that

an experimental plantation has been in existence for a number of years in the Hawaiian Islands.

To be saleable in the United Kingdom, wattle bark must be in good condition and well harvested. The best prices are only obtainable for barks which arrive undamaged by weather or by wet packing. It is stated that the proportion of damaged bark shipped from Natal has been unusually large of late, and allowances up to several pounds per ton have had to be made.

In Germany, most of the imported bark is made into extract, and does not go direct into the tanning pit. As a result, weathered and damaged bark is more readily saleable there than in the United Kingdom.

WATTLE BARK EXTRACT.

Of late years the use of bark extracts has largely taken the place of ground barks for tanning purposes. Extracts are preferred by tanners, since they are quicker and more regular in their action, and there is practically no waste in their use. Quebracho, valonia, oak bark, sumac, and mangrove are all largely utilised in the form of liquid and solid extracts, and their application in this form is being greatly extended from year to year.

Besides these advantages to the tanner, it is clear that advantage also accrues to the producer, since he is able by this means to utilise materials deficient in tannin, and is able to compete in distant markets otherwise closed to him by reason of high freights.

These considerations have been of late the subject of much discussion in the wattle-producing countries, and notably in Natal. The Union already referred to, appears to have decided that the best chance for the expansion of the industry lies in the direction of manufacturing extract in the centre of production of the bark.

Manufacture of Wattle Bark Extracts.

Tanning extract can be placed on the market in either the liquid or solid form. Where it is possible to concentrate the extract sufficiently without decomposition, it is more advantageous to prepare the solid extract, since this is cheaper to pack and to transport. The process of making extracts resolves itself into several sections which may be considered seriatim.

Leaching.—This is the technical term describing the process of dissolving the tannin out of the bark. For this purpose the latter is ground to a fine powder to facilitate extraction. The system of "leaches" or extractors now considered the best admits of continuous working. Pits, or tubs sunk in the ground and built in series or "batteries" of six to eight, are packed with the ground bark, and the liquor obtained by percolation with water in one pit is used to extract the bark in the next leach, and so on until a strong liquor is obtained. Continuity of action is obtained by keeping a high head of water or spent liquor in the end vat of the series, thus forcing the liquor forward from vat to vat by means of a series of vertical pipes. The spare vat may be heated by steam if required.

Wattle bark is best extracted at a temperature of about 60°, beginning cold and raising the temperature gradually. The following table, taken from Procter's *Principles of Leather Manufacture*, shows the percentage of tanning matter and the amount of colour (as measured by Lovibond's tintometer) obtained by extracting Natal wattle bark so long as any colour or tannin could be obtained.

The object of the extract manufacturer should be to remove the maximum amount of tannin and the minimum amount of colour in the minimum of time and with the least possible quantity of water, since the water will later on have to be evaporated. The results recorded in the following table clearly indicate water at about 60° C. as giving the best results when all these requirements are taken into consideration.

Temperature at which extraction is conducted.	Tannin.	Non-Tannin.	Percentage of Tannin on maximum.	Colour of ½ per cent. solution in ½-inch cell.		Percentage of colour on maximum.
				Red.	Yellow.	
° C.	*Per cent.*	*Per cent.*		*Degrees.*	*Degrees.*	
15	21·2	11·6	66·2	2·6	4·1	51·1
15—30	29·0	9·8	90·6	3·0	4·1	54·2
30—40	30·1	9·8	94·0	3·0	4·4	56·5
40—50	30·2	9·8	94·4	3·1	5·0	61·8
50—60	30·4	10·4	95·0	3·9	6·5	79·9
60—70	31·5	10·6	98·4	4·2	6·5	81·6
70—80	32·0	10·8	100·0	4·2	7·0	85·5
80—90	30·8	11·2	96·2	4·9	7·4	93·8
90—100	30·1	11·8	94·0	5·3	7·8	100·0
boiled	29·4	12·0	91·8	5·7	7·2	98·4

Decolorisation.—As in the case of most extracts, it is probable that wattle extract will generally be improved by decolorisation. The agent usually employed for this purpose is dried blood, but pastes of blood-albumen, alumina, and casein are also occasionally used.

The blood or albumen is dissolved in a little water, added to the vat liquor obtained as described above, and well mixed. On raising the temperature to 70° C. the albumen coagulates and carries down much of the colouring matter, which is allowed to settle, after which the clear liquid may be drawn off for evaporation.

Decolorising always occasions a certain loss of tannin, and for this reason is dispensed with when not absolutely necessary. Sulphurous acid is frequently used to "brighten" tan liquors, but its use should be unnecessary in preparing wattle bark extract; it is said to be disadvantageous in various ways.

Concentration of the Liquor.—The liquors from the leaches or decolorising vats are concentrated by evaporation. Up to a certain stage it is possible to use for this purpose "spray" machines of the Yaryan type, which concentrate the liquid with as little access of air and at as low a temperature as possible. This result is obtained by passing the liquid into copper tubes working under reducing pressure and kept at the required temperature. The fluid is immediately converted into spray and swept forward into a separating chamber. In this way the liquid can be concentrated up to a specific gravity of 1·1 to 1·2 without having been heated above 70° C. The final evaporation of the extracts is conducted in ordinary vacuum pans. It must be understood, of course, that in all stages of its manufacture the extract must be kept from contact with iron. The apparatus is usually constructed of wood and copper.

In the foregoing account of extract manufacture an outline of the process only has been attempted, and for fuller details both of the process and of the plant required, Prof. Procter's handbook already referred to might be consulted with advantage.

Considerable quantities of wattle extract are already manufactured in Australia, and a factory has been established in South Australia for its preparation, chiefly from branch bark, which is too small to pay for stripping. A fluid extract is prepared

which contains 60 per cent. of water and about 38 per cent. of soluble tannin. Practical experiments are also being conducted in Australia with a view to the preparation of a tanning extract from wattle leaves. It is probable that where wattle bark extract manufacture is contemplated it would be advantageous to adopt the plan of building a central extract factory conveniently situated with respect to a group of plantations, the produce of which could be worked up in the factory. This plan has been worked successfully in Germany in the manufacture of beet sugar, and more recent instances of its success are the central ginneries for treating seed cotton in West Africa and the West Indies and elsewhere.

CULTIVATION AND UTILISATION OF ANNATTO.

In connection with the question of annatto production in the Colonies, especially in West Africa and Ceylon, the following memorandum has been prepared and is now published for general information.

Annatto is the orange-red colouring matter occurring as a layer of pulp on the outside of the seeds of the annatto plant, *Bixa orellana*, a small tree indigenous to South America but now extensively cultivated in many tropical countries.

The supplies of annatto which reach the United Kingdom at present come principally in the form of the seeds from the East and West Indies, and as paste from French Guiana or Brazil.

CULTIVATION OF THE PLANT.

The annatto plant grows luxuriantly in almost any soil, and in the tropics will thrive up to about 3,000 feet above sea level. The soil is prepared for annatto in much the same way as for cotton. The seeds, previously softened by soaking in water, are planted in furrows at distances of 8 to 10 feet apart. As the young plants come up they should be provided with artificial shade to protect them from excessive heat, but later on a large amount of sunshine is necessary for their proper development.

After three months the plantation should be weeded and superfluous plants removed. Beyond periodical weeding the plantation requires little attention.

Harvesting.

Full crops of seed may be obtained in three or four years from the time of sowing, but the collection of seed may be commenced usually after the first eighteen months or even earlier. The fruit capsules are gathered when they have acquired a reddish colour and are just beginning to break open. This takes place from the pointed end along the edges and causes the seeds to be exposed. It is said to be advantageous to cut the branches along with the capsules, as in this way the plants are prevented from growing so high as to make collection a matter of difficulty, and they bear better.

The capsules are opened out on mats or cloths and allowed to dry completely in the sun, being turned over from time to time. Three or four days' exposure is usually sufficient to accomplish this, and the fruits are then collected into heaps and beaten with clubs or thrashed to separate the seeds. These are separated from the empty pods by winnowing or sifting, and again exposed to the sun until they are completely dry.

The seed is usually packed in barrels for export but manufacturers using annatto in the United Kingdom recommend that they should be packed in double sacks holding from 1½ to 2 cwt. each. Great care should be taken to see that the seeds are dry before they are packed, as if they are at all damp they are liable to become mouldy and lose colour.

COMMERCIAL VALUE OF ANNATTO SEEDS.

The prices obtained for annatto seed in London in the last few years have varied somewhat. Ceylon and Madras seed fetched from 6*d.* to 7*d.* per lb. at the end of 1905 but gradually fell to 3½*d.* or 4*d.* during 1906. Jamaica seed similarly fell from 8*d.* at the end of 1905 to 4*d.* in October 1906. At present 4*d.* per lb. may be taken as the average value. Java seed, which go principally to Liverpool, is at present worth 4*d.* to

5*d.* per lb. The most recent quotations available are 4*d.* per lb. for Madras seed and $3\frac{1}{2}$*d.* per lb. for Ceylon seed.

There is a fair demand for annatto seed in the United Kingdom, and the annual imports are said to fluctuate between 75 and 100 tons, and manufacturers of annatto preparations are of opinion that the demand is likely to grow. There is said also to be an increasing market in the United States for annatto, but this is likely to be met by a larger output from Jamaica. It should be borne in mind, however, that the annatto plant can be grown practically anywhere in the tropics, and that plantations have been formed in many tropical countries, and that if prices rose there would probably be an immediate increase in output from plantations already in existence.

PREPARATION OF ANNATTO PASTE.

At one time considerable quantities of annatto paste were imported into the United Kingdom and other European countries from French Guiana and Brazil, but although text books dealing with annatto dye still refer to the paste as the principal form in which annatto is imported there is reason to believe that this trade has almost ceased. Thus no export figures for annatto paste from French Guiana have been given in the statistical returns for the French Colonies since 1900. Annatto paste was imported into the United Kingdom from Ceylon in considerable quantities some years ago, but owing, it is said, to a falling off in the quality of the material the demand for it diminished.

Manufacturers in the United Kingdom, and merchants handling annatto paste, say that the reason for the decline in the market for this article is entirely due to the practice of adulterating it in the countries where it is produced, and that if a clean paste of good quality were produced it would command a ready sale. Unless, however, a paste of excellent quality can be made it is better to export the seeds.

In Brazil annatto paste was formerly made by crushing the seeds in hot water, decanting the liquid containing the colouring matter in suspension, and evaporating it to a pasty consistence in shallow pans over a fire. More recently, however, in Brazil and French Guiana the uncrushed seeds have been mixed with hot

water and the mass agitated until the whole of the pulp carrying the colouring matter has been washed off. The muddy liquor so produced is decanted through a sieve to remove the seeds. The liquor is then allowed to stand until the insoluble colouring matter held in suspension settles to the bottom when the useless supernatant liquid is poured off and the wet paste or colouring matter is dried by exposure to sun heat. The paste so produced can be prepared for the market in several ways. It may be formed into rolls weighing from 4 to 5 lb. each, and after drying wrapped in banana leaves and then packed in boxes or sacks, as is the custom in Brazil; or it may be made into small cheese-like masses weighing from 1 to 2 ozs., and these, when quite dry, packed in boxes holding from 4 to 5 cwts. The French Guiana variety of annatto is superior in quality to the Brazilian (Spanish).

It will be seen that no special machinery is required for the production of annatto paste by these processes, but doubtless the extraction of the colouring matter could be made more efficiently and rapidly if mechanical agitation were employed to keep the seeds in motion while they are in the water, and similarly the separation of the colouring matter from the mother liquor and its subsequent drying could be more cleanly and rapidly effected by the use of a filter press.

Owing to the very small demand existing for annatto paste in the United Kingdom at the present time it is impossible to obtain a satisfactory idea of its commercial value, but it appears that Cayenne paste from French Guiana fetches about 10*d.* per lb. in France at present, and that good qualities of Ceylon paste when imported into the United Kingdom were worth, as a rule, from 1*s.* 6*d.* to 2*s.* per lb.

USES OF ANNATTO.

At present annatto is principally employed as a colouring agent for food materials such as butter, margarine and cheese. It was formerly used in considerable quantity for dyeing silk, but is now little employed for this purpose as better dyes less fugitive to light are available.

NATIVE LEATHER OF WEST AFRICA.

IN previous numbers of this *Bulletin* (1906 **4**. 75 and 366) reference has been made to the increasing popularity of West African leather (Niger or Sudan skins) for bookbinding and other purposes, and to the attempts which have been made in recent years to encourage its export from West Africa.

The leather consists of the tanned and dyed skins of goats and sheep and is produced for local use throughout the Sudan, in the hinterlands of Morocco and Tripoli, and also Southern Nigeria, but the principal centres of the industry are the provinces of Bornu and Kano in Northern Nigeria, and the chief market for the leather is Kano. The trade there appears to be mainly in the hands of the Tripoli Arabs, and the skins are principally exported by caravans across the Sahara to Tripoli, whence they are shipped chiefly to the United States, though small quantities are also sold in France, Italy and Austro-Hungary.

The great value of this trade may be gathered from the following list of values of exports of skins from Tripoli in recent years:—

	Value £		Value £
1896	48,500	1901	44,400
1897	48,000	1902	24,000
1898	65,000	1903	43,200
1899	59,000	1904	37,480
1900	58,500	1905	44,320

It will be seen that the values of the exports fluctuate considerably, and this appears to be mainly due to the insecurity of the routes across the Sahara from Kano to Tripoli, and consequent failures of supply from time to time; thus Mr. Consul-General Jago in a report on the commerce and trade of Tripoli in 1902 (Diplomatic and Consular Reports [Cd. 1386–58]) states that "the gloomy outlook of the caravan trade with Kano—the only direct one now left to Tripoli and now reduced to one-fourth of its ordinary dimensions—was accentuated by the capture in June last, in the Damerghu country, of a rich Tripoli caravan homeward bound, which only

increased the general depression. A caravan now arriving at Tripoli from Kano, 1,220 camel loads strong, consisting of 200 loads of feathers, 1,000 loads of Sudan skins, and 20 loads of ivory, has been eleven months on the journey from Kano, including a stay of three months at Zinder, one month at Aïr, and one month at Ghat. This is the first caravan to arrive from Kano for two years, owing to the general insecurity of the roads, the safety of which between Kano and Aïr was in the present instance secured by a French military escort. The cost of transport from Kano to Tripoli is calculated at £27 per ton." In more recent Consular reports on Tripoli, references to the capture of caravans by the nomadic tribes of the Sahara in 1904 and 1905 occur. It is hoped that in view of the immense difficulties which transport across the Sahara offers, trade from Kano will be gradually diverted to the South, though it is clear from Sir F. Lugard's report on Northern Nigeria for 1905–6 (Colonial Reports—Annual [Cd. 3285–3] pages 80 and 81) that there will be some difficulty in inducing the Tripoli Arabs, who seem to control this trade in Kano, to discontinue the use of the desert route. Small quantities of these skins are, however, now beginning to be exported to this country from West African ports.

PREPARATION OF WEST AFRICAN LEATHER.

As already stated, this leather is prepared by tanning goat- and sheep-skins, the latter variety forming perhaps about 20 per cent. of the total export. In spite of the fact that this leather has been exported to Europe from very early times practically nothing is known regarding the methods by which it is tanned and dyed, although there are occasional references in the writings of the earlier West African travellers to the production of leather in Bornu and Kano. The skins almost invariably come into the market dyed, the usual colours being buff, red or reddish brown, yellow, and green or greenish blue. The natives used a good deal of this leather themselves for the manufacture of articles of dress, pillow covers, saddlery, etc., and a number of such articles made from Kano leather are shown in the West African Court of the Imperial Institute.

These goods are made from dyed leather of the usual types, but are generally decorated either by interlacing differently coloured leathers or by tracing on them various patterns in black lines, the usual form of ornament including diamonds, squares and circles.

A good deal of interest attaches to the methods by which this leather is prepared, as it was recommended by "the Society of Arts Committee on Leather for Bookbinding" as a satisfactory material for this purpose since it was likely to last better than the East Indian tanned skins largely used for cheap bookbindings.

At the suggestion of the Imperial Institute several officers in Northern and Southern Nigeria have made inquiries on this subject, and from the information received in this way, principally from Mr. Dudgeon, Superintendent of Agriculture for the West African Colonies and Protectorates, and from Mr. Gowers, the Resident of Bauchi Province, the following summary has been compiled: the whole process may be conveniently divided into three distinct branches, viz. (1) depilation or unhairing; (2) tanning, and (3) dyeing. In European practice a fourth stage technically known as "bating" occurs between the depilation and the tanning proper. The object of the "bating" operation is to neutralise the lime or alkali necessarily used in the unhairing of the skin, and bring the latter into a condition in which it readily and evenly absorbs the tannin in the next stage.

Although no actual "bating" operation is carried out in the preparation of Nigerian leather it is probable that it really takes place in the tanning process, since the tanning material used, the pods of the "Bagarua" tree, readily ferment and are, in fact, actually used as a "bate" in certain parts of India.

Observations by Mr. Hoffmann, for some time agent to the British Cotton Growing Association at Oyo, Lagos, and by the Resident of Bauchi, agree that the depilation of the goat- or sheep-skin is accomplished by means of wood ashes, the former stating that the skins, as received from the native butchers, are at once placed in earthenware pots containing a mixture of wood ashes and water, whilst the latter says that the skins are first washed and then placed in ashes for twenty-four hours. The hair is then scraped off with a blunt knife and the cleaned

skin, according to Mr. Hoffmann's account, is allowed to dry for a day and then placed in a second earthenware pot containing water and the crushed pods of a tree known as "Bonni." Mr. Gowers, on the contrary, states that the skins after depilation are placed for a day in an aqueous decoction of the stems of a plant known as "Serri." This may prove on further examination to be a separate "bating" process, but unfortunately it has proved impossible so far to identify with certainty the plant known as "Serri," so that no definite opinion can be expressed on this point. Mr. Gowers continues that after removal from the "Serri" decoction the skin is scraped, rubbed and pulled until it is thoroughly soft and pliant, when it is immersed in an infusion of the pods of the "Bagarua" tree, and during the whole time of its immersion in this liquid it is kneaded at short intervals. At Oyo, according to Mr. Hoffmann, the sun-dried, unhaired skin is placed in a pot with water containing the fruits of a tree known as "Bonni," and left there until it is thoroughly tanned through when it is taken out and dried in the sun.

The account given by Mr. Dudgeon from information derived from leather workers at Inga, Bobi, and Kontagora in Northern Nigeria, differs materially and in important points from those given by Mr. Hoffmann and Mr. Gowers—particularly in the fact that the skin is not immersed in an alkaline liquid to facilitate depilation. He states that the skin is generally pegged out and dried, though it may be treated directly in the fresh condition. It is then placed in a calabash containing water and the powdered pods of an acacia, and left there during three days, after which it is removed, pegged out on a board and scraped with a bent knife until all the hair is taken off. The skin is then permitted to dry and when finished is of a pearly white colour. All three observers agree that the tanned skin is next oiled by rubbing in either palm oil, ground nut oil, or shea butter, the skin being meanwhile rubbed and pulled by hand until it becomes quite soft, when it is ready for dyeing.

Production of red leather.—Red dyed skins appear to be the sort most generally produced, and it is this variety which usually reaches this country. It has been stated that the well-known red dyestuff, camwood, which is commonly found throughout

the greater part of West Africa, is used for dyeing leather red, but Messrs. Dudgeon and Gowers both agree in stating that the stems of a variety of Sorghum known as "Karrandeffi" are used for this purpose. These are pounded up and treated with an aqueous solution of "potash," obtained by extracting wood ashes with water, when a brilliant almost crimson liquid is obtained, which is rubbed into the skin until the latter acquires the desired tint. The skin is finally washed with water to which a little lime juice has been added, and after drying in the sun is ready to be packed for transport.

Dyeing of yellow leather.—As a source of yellow dye a root known as "Gangammo" is used, and this is merely powdered up, mixed with water, and the mixture rubbed into the skin, which is then finished off as for red leather.

Preparation of green leather.—The skins of this type, which come into the market in this country, vary in colour from vivid green to bluish green, or almost pale blue, and it has been suggested that these tints are produced by the use of a combination of indigo with a yellow dyestuff, which might account for the preponderating blue tint shown by some specimens. According to the information supplied by Mr. Dudgeon "aniline green," a synthetic dyestuff imported by the European trading factories, and regularly sold, in addition to magenta, in the markets of all the larger towns, is now regularly used for dyeing leather, at any rate in the neighbourhood of Zungeru, Bobi, and Kontagora. Mr. Gowers, however, states that in Bauchi the dyeing mixture for green is made by mixing brass filings with a white salt called "Sunaderi," also used by native metal workers in brazing and welding metals, and adding to this, milk mixed with an infusion of tamarind fruit or lime juice. This mixture rapidly becomes green, especially if a small quantity of a previous preparation be added to it. This dyeing mixture is then poured on to the *inner* side of the skin and thoroughly rubbed in by hand until it permeates the skin and appears on the outside surface. The skin is then put aside to dry, and when quite dry the deposit left on the inner side is carefully scraped off and used again. Sheep-skins are preferred for the preparation of the green leather as they are thinner than goat-skins.

Materials used in the preparation of West African leather.

Specimens of most of the materials referred to in the foregoing account have been sent to the Imperial Institute by the officers already mentioned, in illustration of the memoranda they have prepared on this subject, and most of them have been subjected to examination, and the following additional information regarding them may be given.

Bagarua pods.—Samples of these pods and a herbarium specimen of the tree yielding them have been received and identified by the authorites at Kew as *Acacia arabica*. The pods of this tree are used, as already stated, under the name "Babool" pods, in India, as a "bate," and also as a tanning material; in the Sudan they are largely used for tanning, and are known as "Sant" pods. They are occasionally exported from West Africa as "Gambia pods," and have been used to a small extent in this country as a tanning agent. The results of an analysis of a sample of "Sant" pods from the Sudan have been given already in this *Bulletin* (1906, **4**. 95). The sample received from Northern Nigeria contained only 26 per cent. of tannin as compared with 35 per cent. found in the Sudan sample, but was otherwise of good quality and yielded a soft, almost white leather of good texture. These pods seem to be somewhat variable in the amount of tannin they contain since Procter ("Principles of Leather Manufacture") mentions a sample containing only 12 per cent. It is probable that the "Bonni" fruits mentioned by Mr. Hoffmann in his account of leather preparation at Oyo are also those of *Acacia arabica*.

"*Karrandeffi*."—This material, used to produce red leather, has not been identified botanically, but it is hoped that specimens suitable for this purpose will be forthcoming. It is known, however, to be derived from a species of Sorghum. This product is identical with a Sudanese dyestuff known as "Sikhtyan" used both for dyeing leather and for staining "lanzura grass" employed for plaiting into grass mats. In the Sudan the dyestuff appears to be used without the addition of "potash" or wood ashes. A sample of "Sikhtyan" from the Sudan was examined for the Imperial Institute by Mr. A. G. Perkin, F.R.S., who states that it is a substantive, red dyestuff of the same type

as camwood, red sandal-wood and barwood, all of which are supposed to contain the same red dye called "santalin" or "santalic acid."

"*Gangammo root.*"—This yellow dye both Mr. Dudgeon and Mr. Gowers suggest is probably turmeric, and the sample sent to the Imperial Institute somewhat resembles the poorer qualities of turmeric as imported into this country from India.

"*Sunaderi.*"—The white crystalline salt used in the green dye mixture proves on examination to be pure ammonium chloride. It is not known at present whether this material is imported through European traders, but there is some reason to believe that it is brought into the northern portions of Northern Nigeria by Tripoli Arabs from the Sahara.

It is clear from the foregoing account that whilst the process in use in various parts of West Africa for the preparation of these skins is much the same there are variations in details in the different districts in which the industry is carried on.

It has frequently been suggested that a larger market for these skins could be created if they were exported in the undyed condition, since they could then be dyed to any desired colour in Europe, and this would increase the range of purposes to which they could be applied. Reference has already been made in this *Bulletin* (1906, **4**. 366) to the fact that these skins are sometimes exported in a defective condition, the principal defect being due to damage caused by careless flaying, and the necessity for securing more careful treatment of the skins has been pointed out.

OCCURRENCE AND USES OF MOLYBDENUM ORES.

IN view of the interest shown recently in the employment of metallic molybdenum as a "steel hardener," the following summary of data available regarding the occurrence and production of the ores of this metal has been compiled, since the numerous inquiries on this subject received at the Imperial Institute indicate that such information is not readily accessible.

Molybdenum is an essential constituent of the minerals molybdenite, wulfenite, molybdite, powellite, belonesite and ilsemannite; the first two of these being the more important from a commercial standpoint, the remainder being, at present, of scientific interest only.

MOLYBDENUM ORES.

Molybdenite usually occurs in foliated masses, although tabular crystals are sometimes found. It is a soft, lead grey, sectile mineral giving a bluish-grey streak on paper and a slightly greenish streak on porcelain. It has a hardness of 1 to 1·5 and a specific gravity of 4·8; this latter constant serves as a ready means of distinguishing the mineral from graphite (specific gravity 1·2 to 2·4), which it much resembles in appearance. The mineral corresponds in composition with the formula MoS_2, and, therefore, when pure contains 60 per cent. of molybdenum and 40 per cent. of sulphur. It usually occurs associated with igneous rocks or their metamorphic derivatives. Although it is found disseminated throughout granites and gneisses, it occurs in greater abundance in the quartz veins which traverse these rocks, and, in fact, the commercial sources of the ore, at the present time, may be said to be these veins and the pegmatite dykes in granitic rocks. The mineral has also been found in mica-schist, syenite, serpentine, pyroxenite, basalt, and gabbro (A. R. Crook, *Bull. Geol. Soc. America*, 1904, **15**. 284).

Wulfenite.—This mineral, which is a molybdate of lead, varies in colour from orange-yellow to red and crystallises in square tabular crystals in the tetragonal system. Its hardness varies from 2·7 to 3 and its specific gravity from 6·7 to 7. The streak is white and the lustre resinous. Owing to its often containing other metallic elements it is not usually regarded with favour as a source of molybdenum.

Molybdite or molybdic ochre.—This consists chiefly of molybdic oxide MoO_3, and when pure contains 66 per cent. of the metal. It occurs in tufted and radiated capillary crystallisations of a straw or nearly white colour. Its hardness is between 1 and 2, and its specific gravity is about 4·7. This mineral frequently occurs associated with molybdenite from which it has been derived by oxidation.

DISTRIBUTION OF MOLYBDENUM ORES.

Europe.

British Isles.—Molybdenite is sometimes met with in the Cornish copper and tin mines, but usually not in paying quantities. It is stated to have been worked in some of the chloritic schists of Inverness. At the Mount Sorrel quarries of Charnwood Forest it occurs on the smooth joint faces of the syenitic or fine-grained granite rocks, and is said to have been raised at Calbeck Fell, in Cumberland.

Austria.—Molybdenite occurs in quartz on the slopes of the Erzgebirge, at Zinnwald and Schlackenwald.

Germany.—A small quantity of molybdenum ore is obtained from deposits on the Saxon side of the Erzgebirge, where it occurs in quartz and a hard greenish marl.

Norway.—The deposits at Flekkefjord are being exploited by a British company; during 1905 the output of 95 per cent. molybdenite was 29 tons. Wulfenite has been mined near Egersund. The same ore has also been found in a hornblende gneiss, associated with the copper ores, which occur on the south coast in the neighbourhood of Arendal, and in the valley of Numedal.

Sweden.—In the island of Ekholmen in the Archipelago of Westervik, molybdenite occurs and has been worked in a hornblende gneiss associated with molybdite and copper pyrites. The veins carrying the minerals vary from 6 inches to 2 feet in thickness, and have yielded lumps of pure molybdenite weighing up to 5 lbs.

South Africa.

Natal.—Outcrops showing molybdenum ore occur at Impendhle, at the foot of the Mahotoya Range, Hlatimba River. The ore is said to occur as an oxide impregnation in sandstone beds, which outcrop over an irregular area, the greatest length of which is three miles.

The material raised is said to carry at least 8 per cent. of molybdenum, and another rare element, probably uranium, is reported to be present. It is stated that in this deposit the

molybdenum ore can be leached out with water. Five boreholes have been sunk and there is reported to be an abundance of ore, about 64 tons of which was exported in 1905 for experimental purposes.

Transvaal.—Wulfenite has been found in small quantities in the Transvaal silver mines, Leydsdorp district. It is considered likely that molybdenite may be found in the vicinity.

Australasia.

New South Wales.—In this State molybdenite is usually found at the junction of the granite and the rock into which it has intruded. All granites of New South Wales, however, do not contain the mineral, the coarse and fine sandstone-like varieties being the most productive. The greater quantity of the molybdenite produced is obtained from the Kingsgate mines, near Glen Innes, where it occurs together with bismuth in the quartz in pipes of approximately cylindrical shape which vary from 10 to 50 feet in diameter. These pipes often unite, at 30 to 40 feet below the surface, into one large cylindrical body. An occurrence at Whipstick, near Pambula, is similar to the above. Molybdenite is rather common in the New England tin districts, especially at the Elsemore and Newstead mines, where it occurs in the tin veins which traverse the granite.

The ore is also known to occur at Bullen Flat, Co. Argyle; Kiandra, Co. Wallace; Cleveland bay, and many other localities, a full description of which will be found in "Mineral Resources," No. 11—Molybdenum, *New South Wales Geological Survey.*

Queensland.—The principal ore-producing districts are Hodgkinson and Herberton, and, in fact, almost the entire production of this State in 1905 was obtained from the first-named district.

Molybdenum occurs in pipe veins in a biotite granite at Wolfram Camp (Koorboora), and is said to be obtained in increasing quantities as the deeper ground is broken. The ore is very friable, and for this reason it has been difficult to separate profitably the fine molybdenite from the quartz, but machinery is said to have been recently introduced for the concentration of the mineral and the treatment of the accumulated tailings. A promising deposit occurs at Bamford, where, although the occur-

rence is less frequent, the output is steady and promises to continue. The Townsville mineral field showed a small production of the mineral in 1906. Molybdenite has been found at Moonmear, near Mt. Morgan, where it occurs in the joints of the felsites in small masses a few inches in diameter.

South Australia.—Here molybdenite is worked at North Yelta as a by-product of copper mining; an ore containing 95 per cent. of the mineral is produced from the copper lode in which it occurs in small but uniform quantities.

Victoria.—Molybdenum ores are not known to occur in paying quantities in this State, but molybdenite has been observed in certain reefs in the Moliagul district, and also in granitoid rocks at Yackandandah, in Bogong; Yea, Yarack in Anglesey; and other localities

Tasmania.—Molybdenite occurs in minute quantities disseminated in porphyry and granite in the Shepherd, Murphy, All Nations and Packetts sections of the Middlesex district, Devon County. It has also been noticed at Heemskirk, Mt. Ramsay, Mt. Morris, Schoutin Island, Cape Barren Island and Branxholme. No information is available as to the extent of these occurrences.

New Zealand.—Molybdenite was discovered in 1898 at the Iron Cap mine at Tarauru, Thames, where it occurs in nests and small strings near an ironstone vein. Individual fragments carry about 40 per cent. of molybdenum, but further prospecting is necessary to prove the value of this deposit. The ore also occurs on Dusky Sound on the west coast of Otago; in auriferous quartz in the Paparoa Range. Molybdenite has been found recently in connection with a copper deposit at Mount Radiant, at the head waters of the Mokihinui and Little Wanganni rivers. The mineral occurs in quartz and felspar veins, which also carry chalcopyrite and iron pyrites. More development is necessary to determine the commercial possibilities of this deposit. Wulfenite is known to occur in Dun Mountain, Nelson.

America.

Canada.—The ores of molybdenum so far found in Canada are molybdenite and molybdite. Although these are known to

occur in many localities, distributed all over the Dominion, little is known as to the value of the deposits beyond that shown by surface indications. Ontario is practically the only province in which the ore has been raised to any extent. A deposit has been worked at Sheffield, Addington Co., since 1903. The mineral occurs here with iron sulphide, in a granite country rock, and as mined, contains about 4 per cent. of molybdenum. In 1903, 600 tons of this rock yielded 85 tons of molybdenite. A full account of the many occurrences of this ore in Canada will be found in Bulletin No. 872, published in 1904 by the Geological Survey of Canada.

A process of concentration invented by Mr. J. W. Wells of the Kingston School of Mines, and said to have been employed for molybdenite with some success, has already been described in this *Bulletin* (1903, **4**. 213).

United States.—Wulfenite is obtained from the copper mines of Mammoth and Troy in Pinal County, Arizona. The mineral was at first obtained from the accumulated tailings, but a concentrating plant has now been erected for the recovery of wulfenite from the crude ore, of which it constitutes from 1 to 3 per cent. This deposit is practically the only one in the United States at present producing the mineral.

One of the most important deposits of molybdenum ore in the United States is said to be that at Cooper, Washington Co., Maine, where the mineral occurs as short crystals in pegmatite dykes in the granite. These dykes vary in width from a few inches up to several feet, the molybdenite being most abundant at the contact between the dykes and the country rock. The deposit has been developed and a concentrating plant erected. A second important deposit is situated in Washington, about thirty miles from the head of Lake Chelan. The molybdenite occurs in a quartz vein, which outcrops nearly horizontally above 900 feet up an almost perpendicular granite cliff. It is found in veins up to several inches in thickness in the quartz, but has not been found in the biotite granite enclosing the quartz veins. The deposit has been opened up by two tunnels 195 and 80 feet long respectively.

At a point about 30 miles from Dillon, Beaverhead Co., Montana, a deposit of molybdenite has been discovered and

developed to some extent. The mineral occurs in two veins of quartz, each about ten inches thick, which outcrop for a distance of about 300 feet. The granitic country rock between the veins is seamed with molybdenite. A deposit in a carboniferous gulch near Ophir has also been worked to a small extent.

Deposits of molybdenite occur in California at Nelsons, Talure Co.; South of Lida, Inyo Co.; in Boulder and Lake Co., Colorado; and in Idaho on the south fork of the Salmon River, 14 miles from Warren.

Mexico.—Molybdenum ores occur near Temascal Tepec; at a few places in Oaxaca; in the cretaceous limestone at Zimapan, Hidalgo and Tetela del Oro in Puebla, and as an accessory mineral in the silver mines of Nopal and Santa Ines in Guanajarto, and has also been found in some quantity near East Las Vegas, San Miguel Co.

Bolivia.—Deposits occur in Tasna, Chicahs Paria (Department of Oruro), but practically nothing appears to be known regarding them.

West Indies.—A sample of molybdenite from the Virgin Islands has been received recently in the Scientific and Technical Department of the Imperial Institute, for examination. It was labelled "Molybdenite from old tailings heap." On analysis the following results were obtained :—

		Per cent.
Molybdenum	Mo	48·93
Iron	Fe	3·32
Sulphur	S	32·20
Silica	SiO_2	12·15

The material contained some free quartz. Ore of this quality would be marketable under present conditions, but nothing is known as to the quantity of this product available in the Virgin Islands.

Asia.

Ceylon.—Molybdenite has been found by the officers of the Mineral Survey now being conducted in Ceylon, in connection with the Imperial Institute, near Hetimulla, about four miles south of Kegalla. The mineral occurs in a pegmatite vein but the

deposit is neither extensive nor rich in the mineral. A sample received at the Imperial Institute consisted chiefly of molybdenite, but small quantities of graphite, quartz, magnetite, and biotite mica were also present. On analysis the following results were obtained :—

		Per cent.
Molybdenum	Mo .	50·79
Iron	Fe .	2·03
Sulphur	S .	36·89
Alumina, etc. . . .	Al_2O_3, etc.	1·39
Silica	SiO_3 .	3·86
Graphite	C .	4·62

Molybdenite is also found disseminated throughout many rocks in Saffragam, and the iron ore worked by the smelters of Kandyan is said to contain small quantities of molybdenum.

India.—Molybdenite in small quantity has been observed in the Patra River near Máhabágh and the Baraganda copper mine at Urmi, near Dumri, Hazáribágh district, Bengal.

Federated Malay States.—In 1905 small pockets of molybdenite were found in a granite quarry near Bukit Panjang, Upper Perak.

Japan.—Deposits of molybdenite are said to occur in the provinces of Echigo, Izomo, and Hioa, and small quantities of the mineral have been exported, principally to the United States.

PRODUCTION.

The statistics of production of molybdenum ores are very incomplete, but the following figures showing the production in some of the more important centres in recent years are of interest :—

	1904		1905		1906	
	Metric tons.	*Value.*	*Metric tons.*	*Value.*	*Metric tons.*	*Value.*
		£		£		£
New South Wales	25	2,726	19	2,507	32·6	4,798
Queensland	21	2,673	63	8,496	106	15,275
South Australia	2	198	—	—	—	—
Natal *	66	—	—	—	—	—
Norway	30	3,575	46	3,355	—	—
Germany †	15	36	10	7,826	—	—
United States	13	458	—	—	—	—

* *For experimental purposes.* † *Including quartz and mica.*

COMMERCIAL VALUE OF MOLYBDENUM AND ITS ORES.

To meet the present requirements of the market molybdenum ores should contain not less than 42 per cent. of the metal and should be free from other metallic minerals. Copper, in more than minute traces, renders the ore practically valueless.

The price obtainable, as is the case with most of the rarer minerals, is a matter of special negotiation, and information on the subject is therefore not readily secured, but it is stated that ores showing 90 to 95 per cent. of molybdenum sulphide (60 to 63·3 per cent. of molybdenum) fetch at present from 16*s.* to 19*s.* per unit, per cent. of molybdenum, per ton. The price of metallic molybdenum (98 to 99 per cent.) is said to range from 5*s.* to 6*s.* per lb. Ferro-molybdenum containing 50 per cent. of molybdenum is offered at about 3*s.* 9*d.* per lb.

EXTRACTION OF MOLYBDENUM FROM ITS ORES.

There are two methods in general use for the reduction of the ore :—The *alumino-thermic* process yields a product free from carbon, but containing small quantities of silicon and from 1 to 2 per cent. of iron. Alloys with chromium and nickel are also made by this process. The *electrical* process is worked by heating the ore in a carbon tube, employing a current of 350 amperes at 60 volts, when a portion of the sulphur is evolved as sulphur dioxide. On increasing the current to 900 amperes at 50 volts, complete fusion is obtained, and the rest of the sulphur is expelled. The metal produced in this way contains about 7 per cent. of carbon, of which about 1 per cent. is graphitic. The whole of this carbon can be removed by heating the crude metal with molybdic oxide.

Properties of Molybdenum.

Metallic molybdenum is of a silver-white colour and has a specific gravity of about 9. It does not scratch glass, can be readily filed and is malleable. Moist air does not affect it, but when heated to from 500° to 600° C. in air it burns brilliantly.

USES OF MOLYBDENUM AND ITS SALTS.

The most important outlet for molybdenum, at the present time, is in the manufacture of molybdenum steel. The general effect of the addition of molybdenum to steel, up to 4 per cent. may be said to be to increase the hardness, toughness and elongation without the production of any deteriorating effect when the steel is heated or welded.

The use of this element in steel manufacture is largely in its experimental stage, and opinions differ as to the value of the alloy in comparison with tungsten steel. Molybdenum is stated to be about three times as powerful in its action as tungsten. Tool steels may contain from 2 to 4 per cent. molybdenum, and an alloy containing 3 per cent. is stated to be particularly suitable for the manufacture of armour plates. Molybdenum steel at high temperature becomes very hard, but when annealed is softer than tungsten steel. It can be tempered in water without showing fissures, and it is said not to break "cold short" so easily as does tungsten steel. The molybdenum employed in steel works is usually in one of three forms: (*a*) a dark-blue metallic powder containing 95 to 99 per cent. of molybdenum; (*b*) *ferro-molybdenum*, of which typical specimens have the composition (1) molybdenum 87·5, iron 6·4, carbon 6·3 per cent.; and (2) molybdenum 75·8 with less than 2 per cent. of carbon, and the rest iron; (*c*) molybdenum-nickel, containing 75 per cent. molybdenum and 25 per cent. nickel. An alloy with chromium is also made containing 50 per cent. of molybdenum and chromium.

The ammonium salt of molybdic acid is employed in chemical analysis as a reagent for the estimation of phosphoric acid. It is also stated to find a use as a fire-proofing material and as a disinfectant for the upholstering cloth used in railway coaches. Molybdenum salts give a fine blue colour to pottery glazes, and at one time were employed, to a small extent, in the preparation of pigments for textile fabrics. Experiments have also shown that it is possible to employ certain salts of the metal in conjunction with logwood to impart a deep yellow colour to leather.

Fuller information than can be given in the foregoing summary will be found in the following publications:—

"Bulletin on Molybdenum and Tungsten," *Geological Survey of Canada*, Bulletin No. 872.

"Molybdenum," *Mineral Resources of New South Wales*, Bulletin No. 11.

"Notes on Metals and their Ferro-alloys used in the Manufacture of Steel Alloys," *Institute of Mining and Metallurgy*, 1905. 6. **15**. 228.

Mining Journal, 1907, **82**. p. 751.

Mineral Resources of the United States. United States Geological Survey, 1904–05–06.

Queensland. Annual Report of the Under-Secretary of Mines, 1904–05–06.

Mineral Resources of New South Wales. E. F. Pittman.

New Zealand Mines Record, 1905, April.

Reports on the Mineral Industry of Natal, 1904–05–06.

Ceylon. Report on the Results of the Mineral Survey, 1905–06 (Cd. 3762), p. 21.

Bulletin of the Imperial Institute, 1903, **1**. 213.

The Mineral Industry, 1904.

NICKEL DEPOSITS OF SUDBURY IN CANADA.

THE deposits of nickel and copper ores, which occur near the boundary between the districts of Algoma and Nipissing in Northern Ontario, are of interest, not only on account of their extent and commercial importance, but also from the scientific point of view as furnishing evidence that these and similar deposits are of igneous origin, and are produced by differentiation in the original magma from which they and the associated eruptive rocks have solidified.

The town of Sudbury, situated in the centre of the region, is 443 miles from Montreal and 332 miles from Ottawa on the Canadian Pacific Railway. The area in which workable deposits of nickel and copper are known to occur occupies about 400

square miles, extending from Snider Township to Levack in the one direction, and from Drury to Wanapitei Lake in the direction at right angles. The country is an undulating rocky plain varying in elevation from 800 to 1,100 feet above sea-level.

The district consists largely of crystalline or pyroclastic rocks of Upper and Lower Huronian age, which have been intruded into by the nickeliferous and generally basic rocks of post-Huronian age, the denuded portions of which have a roughly oval shape. The Huronian rocks may be divided into the following more or less distinct formations:—

The oldest rocks known in the district consist of more or less foliated and schistose basic eruptive rocks, and occur in intimate association with massive norite. They were at first regarded as sheared and altered representatives of the latter, but it is now known that they were folded and considerably metamorphosed at some time prior to the intrusion of the nickel-bearing eruptive rocks. The more massive type of these old rocks is described by Williams as "gabbro diorite," and consists essentially of hornblende and plagioclase in which the former mineral gives unmistakable evidence of its derivation from pyroxene and the plagioclase has generally undergone saussuritisation. Epidote, zoisite, quartz, magnetite and ilmenite are also common accessory minerals. A closely related rock possessing a ground mass of much finer grain is the hornblende porphyrite, which is found between the towns of Graham and Creighton. Very often the more massive types pass into foliated schistose varieties of which amphibolite is the prevailing type. Metamorphosed clastic rocks of volcanic origin also occur, but are not easily separated from the main mass of schists.

Besides the rocks, which are the direct result of igneous action, there are others of undoubtedly sedimentary origin occupying considerable areas south of the southern nickel belt. They are generally considered to be of Lower Huronian age and consist of felspathic sandstones or "greywackes" frequently interbedded with and passing by insensible gradations into felspathic quartzites, which usually form the summit of the series. Some of the "greywackes" are evidently the result of ordinary degradation and decomposition, but tuffs derived from the consolidation of volcanic ashes form by far the greater part.

A broken band of conglomerates, which appears to indicate an unconformity in the series, runs from north-east to south-west near Strobie mine.

Another group of intrusive rocks consisting of gabbros and norites is found in certain areas. They pierce the highest beds of the clastic series, but appear younger and are of different types from the main mass of the nickel-bearing norite, and as a rule contain no valuable deposits of ore.

A large area of rocks probably of Upper Huronian age extends from Trill to a few miles within Wanapitei Lake, and are circumscribed by the intruded gabbro. They comprise breccias and agglomerates largely of pyroclastic origin, which pass upward into bituminous shales in turn overlaid by a comparatively coarse felspathic sandstone.

The eruptive rocks characteristic of the main belts may be divided into two groups. (1) A basic group consisting of noritic gabbros and diorites with which the nickel and copper bearing sulphides are immediately associated. (2) An acidic group comprising large areas of rock of granitic type with well-marked gneissoid structure, known locally as micropegmatite. The two types pass by various gradations into one another.

The most northerly of these bands extends in a west-north-west direction from Windy Lake to Wanapitei Lake, where it turns south and connects with the southern or main belt.

The southern or main nickel range commences in a narrow band at Trill and extends north-eastward and eastward through Drury, Denison and Garson, a distance of over 35 miles, and has an average width of a mile and a half. Dr. Coleman has shown that these north and south ranges are continuous, and form a roughly oval basin having a length of 36·2 miles and a maximum width of 16·6 miles. Their origin is explained by supposing that the original magma solidified as a great laccolite below the surface which has been exposed by ordinary processes of denudation.

Mode of occurrence of the deposits.

The general opinion held at least by Canadian geologists is that the deposits are not true fissure veins. The ore bodies are of irregular oval-shaped outline, and all have their longer axes

corresponding with the direction of foliation of the surrounding rock. There are three types of these ore deposits in the district. (1) Those which occur on the southern boundary of the norite gabbro are all situated at the immediate contact with the older rocks into which it is intruded. The intrusive nature of the contact consists for the best part of dyke-like forms or veins of sulphide material. Of mines belonging to this group the Blezard mine has been worked to a depth of 200 feet, and the Creighton has been proved to a depth of 400 feet by drilling.

(2) Those developed in connection with the offshoots of the norite extending southwards from the main mass and which are intruded into the older rocks almost at right angles to the planes of foliation and bedding. Several of the more important mines now working belong to this group.

(3) Those associated with smaller and apparently isolated bodies of norite. The separate masses are so similar to the parent eruptive rock that it may be inferred they are probably connected with it below the surface. The best example of this type is the Stobie mine, which has yielded large quantities of ore.

The commercially valuable ores of nickel fall naturally into groups. (1) Ores containing arsenic and antimony, such as niccolite, gersdorffite, chloanthite. (2) Sulphide ores (without arsenic), as, for example, nickeliferous pyrrhotite and pyrite, pentlandite, polydymite, millerite, etc. (3) Silicated nickel ores such as genthite, garnierite, etc.

The arsenides and sulpharsenides belonging to the first group occur principally in veins in intimate connection with eruptive rocks of the peridotite or gabbro type, as, for example, in Saxony, Hungary, Missouri and Colorado.

The second group of nickel copper sulphide ores comprise by far the largest deposits, and it is to this type that the Sudbury ores belong.

Of the third group, the most celebrated are those of New Caledonia. These are generally confined to areas underlaid by intrusive masses of non-felspathic basic magnesium rocks of the peridotite family, which are generally decomposed to a serpentinous material.

The ore bodies of the Sudbury district consist essentially of

pyrrhotite (Fe_8S_9) and chalcopyrite ($CuFeS_2$), the former mineral being largely predominant. The nickel present is not an essential constituent of the pyrrhotite, but is mainly present as a distinct and magnetically separable nickel iron sulphide known as pentlandite, which, according to the analysis, approximates to the formula FeNiS. Many other minerals occur with the pyrrhotite, but perhaps that of most commercial importance is sperrylite, the arsenide of platinum. The platinum becomes concentrated in the matte and at Copper Cliff and Victoria mines assays from 0·4 to 0·5 oz. per ton.

The amounts of copper and nickel in the ore may vary considerably in different parts of the deposit, but the average usually shows from 2 to 3 per cent. of each metal.

Methods of Mining.

The system of mining these ores in Canada has consisted largely of open cast work or the ore is removed by levels and stopes.

The ore is broken up and sorted and then roasted in heaps, which may be from 40 to 60 feet wide, 60 to 120 feet long, and 7 to 18 feet high, and contain 200 to 3,000 tons of ore. The operation occupies from 3 to 6 months. The ore is then treated in ordinary copper smelting furnaces by means of which a low grade matte is obtained containing copper, 13 to 25 per cent.; nickel, 15 to 25 per cent.; iron, 30 to 40 per cent., and sulphur, 18 to 25 per cent. The matte is then "bessemerised," by which process all the iron is eliminated and a matte consisting principally of copper and nickel with 12 to 20 per cent. of sulphur is obtained.

Pyritic smelting has also been employed instead of roasting and the first smelting operation. The enriched matte after "bessemerisation" is generally exported in this condition and much of it is finally worked up at Clydach in Wales.

Specimens of the chief ores obtained at Sudbury are on view in the Canadian Section of the Imperial Institute.

OILFIELDS OF TRINIDAD.

Two reports (Council Papers Nos. 60 and 131 of 1907) by the Government Geologist for Trinidad have been issued recently, giving further information regarding the occurrence and distribution of oil and bitumen bearing rocks in the Island, from which the following summary has been prepared :—

The first is a provisional report on the geology of a portion of the south-west of the Island from the neighbourhood of San Fernando to Cap-de-Ville on the shores of the Gulf of Paria, including a distance of about eight miles inland and a short stretch of the south coast near Erin. It is accompanied by a coloured geological map on a scale of one inch to the mile.

Except for two small Cretaceous inliers near San Fernando and the Ben Lomond Estate, the rocks are of Tertiary age, and are classified by the author, Mr. Cunningham Craig, as Upper, Middle and Lower.

The Upper Tertiary consists of the La Brea Oil Sand with its associated clays, sands, porcellanites and lignitic beds. They include the porcellanites of Cedros and Irois, the Siparia Sandstone and the upper part of the carbonaceous series exposed on the eastern coast. The upper bed of porcellanite at Erin is taken as the base in that district. Such fossils as have been collected from the Upper Tertiary strata are of Pliocene types. The porcellanites of Trinidad are clays indurated by the combustion of hydrocarbons. The Middle Tertiary includes the beds from the Rio Blanco Oil Sand up to the base of the La Brea Oil Sand. The fossils are distinctly Miocene in facies. The character of the sediments varies considerably; in the west the estuarine "Guapo" type, which is chiefly arenaceous, is developed, while further westward and northward it is replaced by the marine "Naparima" type, consisting mainly of clays and marls with occasional thin bands of limestone.

The Lower Tertiary are unrepresented except to a very limited extent between Point Fortin and Point Ligoure. The fossils obtained in other parts of the Island have a distinctly Eocene facies with an admixture of Miocene types in the upper beds.

The total thickness of Tertiary beds in this district is about

2,500 feet. The Middle Tertiary rests unconformably on the Cretaceous where the latter is exposed; while the Upper Tertiary overlaps the Middle.

The anticlinal axes are described in considerable detail, as they are of great importance in connection with the occurrence and exploitation of mineral oils.

They run approximately east and west, and are shown on the map by thick black lines, while the surface indications of oil are indicated by black crosses.

The oil-bearing rocks of the Rio Blanco horizon are well seen in a coast section at Point Ligoure. Out of a total thickness of 1,224 feet shown in the section, only 60 feet are actually impregnated with petroleum, but some associated bituminous sandstones will probably be found to contain oil. The dip varies from vertical at the northern (lower) end of the section to 56° at the southern (upper) end. It diminishes as the strata are followed inland.

Two well-defined lines of pitch deposits mark the outcrop of the oil-bearing strata in the interior. Hundreds of tons have been removed from the surface, but a far greater quantity remains. An analysis of the more liquid asphalt showed 80·40 per cent. of bitumen, the remainder being nearly all water. Fractional distillation gave, after most of the water had been given off, 25 per cent. of illuminating oil, 43·6 of lubricating oil, and 17 per cent. of residual bitumen.

The upper oil-bearing horizon has been traced as far east as Fyzabad, and indications of oil occur at intervals further east to the San Fernando-Siparia road.

On the northern anticline, the upper beds of the Rio Blanco Oil Sand are seen in the coast section at Vance River. Inland the strata are exposed to a much greater extent and a large area is covered by nearly horizontal oil rocks. A sample of oil sand outcropping on the road just north of Vance River bridge was found to contain 17·5 per cent. of bitumen. In the northern part of the Morne L'Enfer Forest Reserve and the ground immediately to the north a very large amount of asphalt and sticky oil has exuded from the oil rocks. Cones of all sizes occur, many still with central craters from which soft asphalt or thick oil slowly issues.

Fractional distillation of oil from a well sixteen feet deep in the outcrop of the Rio Blanco Oil Sand in the Perseverance Estate yielded 8 per cent. of petroleum spirit (boiling below 150° C.), 45 per cent. of illuminating oil (boiling at 150°–300° C.), 29 per cent. of lubricating oil (boiling above 300° C.), and 10 per cent. of residual bitumen. This shows a higher percentage of light oils than would be expected in the case of oil from a shallow well, and there is no reason to suppose that Trinidad oil will, where obtained from a sufficient depth, prove too heavy and asphaltic.

From the Oropuche Lagoon eastwards along the crest of the anticline there are, for some distance, but few indications of oil, the Rio Blanco Oil Sands not reaching the surface, which is occupied by clays. Further eastward estuarine rocks appear from below the clays, and ultimately, where a still lower band of the covering clay is exposed, the gaseous hydrocarbons have forced their way through, producing a mud volcano, which has violent eruptions at long intervals.

Many outcrops of petroliferous strata of Middle Tertiary age are met with on the north-west section between Aripero River and San Fernando, but there is no evidence of the occurrence of important deposits, and the oil-bearing beds seem to be splitting up and thinning out in this direction.

The evidence of oil among the Upper Tertiaries is confined to the area north of the northern anticline. The pitch lake occurs upon a gentle anticline running roughly east and west, and the existence of raised beaches indicates recent elevation. The structure is concealed by surface material derived from a lightly compacted yellow sand, which covers much of the area to the north of the lake; below this is a fine bluish clay occasionally burnt to porcellanite. Beneath is the La Brea Oil Sand which is the source of the asphalt. Wherever the capping of clay is thin, or the oil rock is merely covered by superficial deposits, soft asphalt exudes, forming small cones. The oil rock is exposed on the seashore west of the lake and is a fine dark sand, so charged with bitumen that the upper layers flow slowly. An analysis gave 15 per cent. of bitumen, 29·7 per cent. of "non-bituminous organic matter," 50 per cent. of ash, and more than 5 per cent. of water. It also outcrops in the hollow to the east

of the lake, and is likewise found in a boring in the asphalt of the lake, a thousand feet to the north of the centre, as well as in one to the south of the lake. It cannot be certainly identified in Guapo Bay, and it probably thins out, and at the same time carries less oil in that direction.

The lake pitch contains on an average 39 per cent. of bitumen, 7 per cent. of non-bituminous organic matter, 25 per cent. of mineral matter having the composition of a somewhat argillaceous sandstone, and 29 per cent. of water and gaseous material. It is probable that in each case the so-called "non-bituminous organic material" consists to a large extent of bituminous matter taken up by the argillaceous constituents in such a manner that it cannot be removed by solvents.

The lake is situated 130 feet above sea-level, and is 137 acres in extent. There is an area of very soft asphalt at the centre, and smaller patches near the western margin. At these points a little asphalt is evidently exuding from the parent rock, just as it is to the east and south-east of the lake, but this additional asphalt is far from compensating for the material removed. The pitchlands of La Brea village represents an overflow from the lake that ceased some years ago. The author believes that the lake occupies the site of a submarine hydrocarbon volcano. He is inclined to think that the asphalt of Aripero is also of Upper Tertiary age.

The author considers that the prospects of oil production are distinctly good, especially in the central anticline from Port Ligoure to the San Fernando-Siparia road, and the northern anticline from the western coast to the Oropuche Lagoon. A company has now been formed to exploit the district about Point Fortin and Point Ligoure. He suggests as promising localities for boring, the shallow synclinal basin north of the central anticline, and the central anticline itself, as far eastward as the Oropuche-Siparia road, especially the Fyzabad district. The northern flank of the northern anticline is also regarded as a favourable ground for boring, and even the ground to the east of the lagoon is thought to deserve investigation.

The oil rock, containing 15 to 18 per cent. of bitumen, appears to form excellent material for road making, and as hundreds of

thousands of tons are in sight in accessible places, it might form the basis of an important industry.

In the second report the central anticline is followed to the eastward of the San Fernando-Siparia road. After crossing a portion of the Oropuche Lagoon, it is indicated on the shore of the land to the north of the lagoon by mud volcanoes and other evidence of oil. Further east, where it crosses the Moruga road, it is merely a gentle arch which does not affect the bedding for more than two or three hundred yards to the north and south. At this point the Rio Blanco Oil Sand appears to be some distance below the surface. To the eastward the anticline probably soon dies out.

Three miles further south on the same road, near the Rock River, a more important anticline is met with bringing in Cretaceous rocks. It probably extends to the east coast, where it is mapped as the Central Anticline. The Galeota Oil Sand which occurs on both sides of the Cretaceous inlier shows repeated indications of oil. It is followed by a thick and almost unbroken series of clays.

Drilling is advised on either, but preferably the southern side of the central anticline, especially between the lagoon and the Moruga road, to a depth not exceeding a thousand feet.

No definite localities are recommended on the Rock anticline, but favourable conditions may be expected to the westward, where the Cretaceous rocks must pass below the surface, and the crest of the arch be formed of Tertiary rocks.

The report is illustrated by a coloured map on a scale of one inch to a mile.

The information contained in these reports adds considerably to that already given from time to time in this *Bulletin* (1903, **1**. 51, 180; 1904, **2**. 175; 1905, **3**. 32; 1907, **5**. 198).

REPORTS FROM AGRICULTURAL AND TECHNICAL DEPARTMENTS IN INDIA AND THE COLONIES.

INDIA.

Eastern Bengal and Assam.—In the "Annual Report of the Agricultural Stations in Eastern Bengal and Assam" for 1906–07, just issued, there are a considerable number of results recorded, which are likely to be of interest to those engaged in the cultivation of exotic plants in tropical countries. There are six farms, or experimental stations, in operation in the provincial districts mentioned, and at all these, agricultural experiments are being carried on, but perhaps the most interesting data in the present connection are afforded by the work done at the Rangpur and Wahjain stations. At the former, special attention is being directed to the cultivation of tobacco. The farm does not seem to be particularly well situated for this purpose, or to be well equipped for the curing and fermentation of tobacco, and arrangements are in progress for transferring these experiments to Burirhat, which is situated within the tobacco-growing region of the district. The tobacco popular in the local markets seems to be of a coarse type, consisting of large thick leaves of bright colour, produced by forcing the plants by the liberal application of manure and by leaving only a few leaves on each plant to mature. At the Experimental Farm, trials have been made with a variety of exotic tobaccos, including Sumatra, Cuba, Virginia, Connecticut and native kinds. Of these all came up true to type except the Sumatra variety, which yielded an inferior product. The plantations suffered from a heavy storm in March 1907, and consequently only small yields of the various types of tobacco are likely to be obtained. Experiments have also been made with Greek and Turkish tobaccos, seed for which was obtained through the British Consul at Athens in 1906. The tobacco obtained from the plants raised from this seed is said to be of fair quality, though it is admitted that the "smoke" produced from it is inferior in aroma to that of good Turkish leaf. From the description given of the leaves obtained it appears that these do not at all resemble true Turkish tobacco, being larger and darker in colour, and it is explained that this is due to the different method of cultivation adopted, and it is proposed to attempt cultivation in the Turkish fashion next year at the Burirhat farm. At the Rajshahi and Jorhat farms experiments are in progress on the cultivation of sugar cane and fibres, notaby jute and Caravonica cotton. The Wahjain tropical plantation was established in 1904, with the idea of introducing into this district of the Khasi hills certain of the tropical products of Ceylon and Madras. The chief products now under trial there are, cardamoms, cinnamon, lemon grass, camphor, cocoa,

nutmegs and cloves. Of these the first four seem to be doing well, and an experimental distillation of lemon grass gave a yield of 0·19 to 0·23 per cent. of oil, which is in close agreement with the average yield in Ceylon. It is proposed to work the camphor trees by the Ceylon method, viz. distillation of the twigs and leaves. The report states that the cultivation of cloves and nutmegs in this district is practically hopeless.

These experiments are also mentioned in the "Report of the Agricultural Department, Eastern Bengal and Assam, for 1906–1907," and in addition an account is given of investigations carried out under Provincial Control by private persons, and on Government, Ward's and Private Estates, etc. The principal crops studied were jute, cotton and wheat.

The experiments in jute cultivation have, on the whole, given satisfactory results, and the fibre expert has expressed the opinion that the area suitable for the growth of this plant is capable of very considerable extension throughout Assam, and that the Assam Valley would probably yield results equal to those obtained in Eastern Bengal. This fact is already being recognised by commercial firms in Calcutta, who are conducting experiments with a view to effecting a large increase in the area under cultivation. The Government is co-operating with the Assam-Bengal Railway in an attempt to grow jute on the railway lands adjacent to the main line. These experiments have so far given very varying results, owing to the great differences in the soil and climate of different parts of the country traversed by the railway.

The cotton-growing experiments have generally resulted in failure. Caravonica cotton has been cultivated in several parts of Eastern Bengal and Assam, and the results, although not yet conclusive, indicate that the variety is unsuited to the Province. A trial of Dharwar American cotton in Rangpur gave very unsatisfactory results. Experiments have been made on the hilly land close to the Hill Tippera frontier of Sylhet with Dharwar American, Buri kapas, King's improved American, Caravonica and Spence cottons, and at the end of June the crop appeared to be fairly healthy. In the Rajshahi Division, Banga cotton plants grown on the Jaipur Government Estate gave a good yield, and trials with Egyptian, Sea Island and Garo Hills cotton carried out by private persons are also said to have met with success. Eight varieties of cotton were grown at Chittagong Model Farm, but all gave unsatisfactory results. Various forms of tree cotton are being tested at the Baikunthapur Farm on the Assam-Bengal Railway. In 1906 the plants suffered from the attacks of insect pests, but they were pruned in April 1907, and were afterwards reported to be growing vigorously. At the Krishnapur Farm near Silchar, five annual varieties of cotton were planted, but only one, Dharwar American, was at all successful. Experiments are being made at this farm with tree-cottons, including the Spence and Caravonica varieties;

the results obtained are regarded as satisfactory, although the plants have been damaged to some extent by insect pests.

Experiments in wheat growing in the Assam Valley during the cold weather were made in Kamrup, Darrang and Sibsagar, but gave disappointing results. These results, taken in conjunction with those obtained in previous years, show that there is no probability of wheat becoming a staple crop in the Assam plains. The climate is too humid and the rainfall is too great during the seasons of ripening and harvest.

Punjab.—A record of agricultural work in the Punjab is given in the "Report of the Operations of the Department of Agriculture, Punjab, for the year ending 30th June, 1907," which contains a good deal of information on cotton.

At the Sargodha seed farm, 203 acres were planted with cotton of indigenous and American varieties. The plants grew well at first, but those of the indigenous forms were attacked later by the boll-worm. The pest was entirely destroyed by cutting down the plants on the infested plots and burning them. The American varieties made excellent progress, but unfortunately the crop was considerably diminished by a deficiency of rain during the later period of growth.

During the year under consideration, a large extension took place in the area devoted to the acclimatised American variety known as Dharwar cotton, 1,350 acres being planted in the Jhelum colony and 350 acres in the Chenab colony. It has been found that the cotton from different plants of this variety and even from different bolls of one and the same plant shows considerable variation in quality, and it has therefore been decided to carry out selection experiments with the object of effecting an improvement.

A trial of Egyptian cotton in the Muzaffargarh district has yielded very good results and has warranted further experiments with these varieties in the South-Western districts. Egyptian cotton has also proved successful at the Lyallpur Agricultural Station. The cotton was sown early and, owing to the winter being abnormally warm, harvesting was continued until a late date. For this reason, however, the results are not regarded as justifying any definite conclusions with regard to the prospects of Egyptian cotton in the district.

Several attempts have been made to improve the indigenous cotton, but without any marked success. Experiments with tree-cottons have not given satisfactory results; at the date of the report, the Spence variety appeared to be making most progress, but had not yet produced any bolls.

Experiments are being carried out at the Lyallpur farm and other places with jute and hemp from Eastern Bengal and Madras, and the crops seem to offer great promise of success. Trials are also being made with Australian wheat.

Central Provinces.—An account of the work done at the Experimental Farms of the Central Provinces is given in the "Report of the

Department of Agriculture of the Central Provinces during the year ending 30th June, 1907."

At Nagpur farm, an investigation was carried out with the object of ascertaining which of the local varieties of wheat was the most resistant to rust. Experiments were also made with several exotic varieties. The Nagpur hybrid was not found superior to other forms in this respect, and the best results both as to yield and rust-resisting power were obtained with the "Bansi" variety.

At Raipur, experiments on the cultivation of "juar" (*Sorghum vulgare*) gave good results. This district appears to be unsuitable for cotton growing. Ground nuts and jute were found to grow well and some sugar canes were planted.

At Hoshangabad farm, some Russian flax was grown, and at the date of the Report the fibre was being tested. Experiments on green manuring showed that "san hemp" (*Crotalaria juncea*) was a useful crop for the purpose.

Efforts have been made to improve the cotton of the Central Provinces, and seed-farms have been established for the purpose. Experiments have been carried out at the Nagpur and Akola farms in connection with manuring, the cultivation of exotic varieties, hybridisation and seed selection. With regard to the exotic varieties, success was obtained with one variety only, known as "Bari," an American form acclimatised in Bengal, and this is stated to have given a good yield of cotton. The hybridisation experiments have not yet given definite results.

Bombay.—The following information is given in the "Annual Report of the Department of Agriculture, Bombay Presidency, for 1906–1907":—

The cultivation of Egyptian cotton in Sind has undergone considerable extension, no less than 5,100 acres having been planted in Thar and Párkar. Unfortunately, however, the season was unfavourable and the crop was affected by the boll-worm. It is considered that suitable conditions for the propagation and spread of the boll-worm were afforded chiefly by the seed having been sown too thickly, and the plants having been watered too copiously. During the present season, an attempt is being made to check the ravages of this pest by the introduction of its principal parasite (*Rhogas Lefroyi*). Mitafifi cotton is regarded as superior to Abassi for cultivation in Sind.

Since it has been found that Broach cotton could be grown successfully under irrigation at the Mánjri Station, seed was distributed to cultivators in the Deccan for trial on lands intersected with irrigation canals. Instructions were issued for the guidance of the planters, and the cultivation was supervised by an officer of the Agricultural Department. A total area of 118 acres was planted, but only 4·2 per cent. of this gave successful results; specimens of the crops were regarded as from 3 to 12 per cent. below good Broach in quality.

Attempts are being made to effect improvement in the cottons of

Bombay by selection of seed, and also by means of hybridisation. A new hybrid produced for the Surtee Broach tract by crossing "Kumpta" with "Goghári" has been found to be 12 per cent. better than the ordinary variety when grown under similar conditions.

An investigation has been made of Khándesh cotton. This cotton is a mixture of several varieties, and its quality depends principally on the proportions in which the different varieties are present. Attempts to isolate and identify the various forms have shown that the six chief components of the Khándesh mixture are: (1) "Jari A" (*G. neglectum*, var. *vera*); (2) "Jari B" (*G. neglectum*, var. *vera*, subvar. *malvensis*); (3) "Jari C" (*G. neglectum*, var. *vera*, subvar. *Kathiawarensis*); (4) "Bani" (*G. indicum*); (5) "Varádi A" (*G. neglectum*, var. *rosea*); (6) "Varádi B" (*G. neglectum*, var. *rosea*, subvar. *Cutchica*).

On the Nadiád Station attempts have been made to improve the coarse tobacco of the district in order to render it suitable for European consumption. In particular, an investigation is being made of the value of indoor curing as compared with the usual open-air method.

Experiments with jute did not give good results owing to the poor quality of the seed employed. One plot at Ganeshkhind, however, yielded 608 lb. of fibre per acre. Further trials are being made.

Quick-ripening, foreign varieties of ground nuts were distributed to selected cultivators and proved very successful.

CEYLON.

In a memorandum forwarded recently to the Colonial Office by the Governor of Ceylon, an account is given by the Mycologist to the Ceylon Government of the "Cocoa-nut stem bleeding disease," and of the steps taken to eradicate it from the plantations in the island. From this memorandum it appears that the disease has probably long been in existence in Ceylon, and many of the planters seem to have been aware of the occurrence of "bleeding" in the stems of the palms without supposing that this was a symptom of disease. The fungus causing the disease was isolated successfully in September of last year, and shown to be identical with *Thielaviopsis ethaceticus*, Went., a well-known parasite of the sugar-cane in Java, Mauritius and the West Indies. The connection of the disease with this parasite was established definitely by the inoculation of palms with pure cultures of the fungus, the inoculated palms beginning to show symptoms of the disease in February last. The fungus enters the tree through cracks in the outer layer of the stem, and causes the decomposition of the internal tissue. After some time (three months in the case of the experimentally inoculated trees) a brown liquid issues from the cracks and forms on the exterior a rusty patch, which afterwards turns black. On old trees the disease does not penetrate the dense "wood," and therefore does very little damage. But on young trees it penetrates into the centre of the tree and destroys the whole of the interior, though even in bad cases

it seems to stop short of the "cabbage" or apical bud, and so the tree continues for a time to bear fruit. The fungus lives entirely within the decaying tissue and its spores are brought to the exterior by the exuding sap, and it is thought that they are conveyed from tree to tree by squirrels and other animals. In spite of the attention the disease has attracted recently in Ceylon, the Mycologist thinks it improbable that it has increased to any great extent during the last few years. Lectures have been delivered to planters on the disease, and special circulars have been published describing the symptoms and suggesting remedial measures, and now that the nature of the disease is known active measures are being taken by planters to prevent it from spreading to any serious extent. Inspectors have also been appointed to instruct the native headmen in the treatment of the disease and to secure the treatment of trees in areas known to be affected.

The treatment suggested is to cut out and burn all diseased tissues, the wound being scorched with a torch of rags dipped in oil, or by other means, and then covered with hot tar. On large estates young trees are being sprayed with Bordeaux mixture as a preventive of infection.

NEW ZEALAND.

Of the work recorded in the "Report of the Chemistry Division of the New Zealand Department of Agriculture" for 1907, the following matters are of special interest:—

The cultivation of sugar beet was continued at the Ruakura and Moumahaki Experimental Farms with satisfactory results. The crop at the former, which was manured with 7 cwt. of a mixture of dried blood with bone manure per acre, yielded roots in some cases weighing from $3\frac{1}{2}$ to 5 lb. each, and containing from 14·25 to 16·7 per cent. of sugar calculated on the fresh roots. This is contrary to experience in America, where it is the exception to find roots over 20 ounces in weight giving a high yield of sugar. The ash of the expressed juice was low and varied from 0·48 to 0·52 per cent.—a matter of some importance, as it is stated that each unit per cent. of salts present in the juice prevents 5 per cent. of sugar from crystallising. At the Moumahaki Farm, where the crop was manured with 3 cwt. of superphosphate per acre and a top-dressing of stable manure, several varieties of beet were grown, and the results recorded show a sugar content of 6·2 to 16·3 per cent., the roots being of good shape and texture and weighing from $2\frac{1}{2}$ to $3\frac{3}{4}$ lbs.

It is suggested that in future experiments should be made to determine the varieties of beet best suited for cultivation in the Colony.

A Government bonus has been offered for the discovery of deposits of mineral phosphates in the Colony, and as a result over 500 samples of supposed phosphates were submitted for examination. Most of these proved valueless, only three samples of true phosphate being received. Two of these were obtained near Whangarei, one being a white material

containing 87 per cent. of tricalcic phosphate, and the other a brown boulder showing 78 per cent. A crude greenish specimen from Port Robinson contained 37 per cent. of phosphate of calcium, and a large white boulder from Kamo, Whangarei, contained 62 per cent. These specimens indicate the possibility of there being workable deposits of the mineral in North Island.

The problem of cultivating saline soils of brackish estuaries or reclaimed sea frontages has also received the attention of the Department. An ingenious method of rendering saline land suitable for cultivation is recorded from Motukaraka, Lake Ellesmere Flat, Canterbury. A number of artesian wells were sunk and the water allowed to flow over the surrounding soil, which after being freed in this way from its saline matter, has yielded good crops of clover and grasses.

The necessity of a complete soil survey of the Colony is urged, and it is suggested that the survey party should consist of a surveyor, an agricultural chemist, and an agriculturist, and that the climatic conditions, geological origin and flora of the soil, as well as its economic conditions, should be recorded as a guide to present or future settlers.

The results of an investigation of the bark of the Pukatea (*Laurelia Novæ Zealandiæ*), one of the most characteristic trees in swampy forests of North Island, are given; from which it appears that the bark contains a new crystalline alkaloid. To this alkaloid is attributed the property possessed by the bark of causing a tingling sensation on the tongue when it is chewed.

GENERAL NOTES.

British Cotton Cultivation.—The Colonial Office has issued as a Parliamentary Paper (Cd. 3997 of 1908) a report by Professor Dunstan, Director of the Imperial Institute, on the progress of British Cotton Cultivation, including the results of the examination of cotton, for the most part experimentally grown in British Possessions, which has been carried on at the Imperial Institute during the past five years. An account is given of the progress of cotton cultivation and the quality of cotton grown in the following countries: Cyprus, Sudan, East Africa Protectorate, Uganda, Nyasaland, Rhodesia, Transvaal, Orange River Colony, Natal, Cape of Good Hope, Gambia, Sierra Leone, Gold Coast, Lagos, Southern Nigeria, Northern Nigeria, Mauritius, Seychelles, Straits Settlement and Federated Malay States, British North Borneo, South Australia, British New Guinea, West Indies, British Guiana, British Honduras and Bermuda.

Yebb or Yeheb Nuts from Somaliland.—With reference to the article on "Yebb Nuts from Somaliland" in this *Bulletin* (1908, **5**. 19)

it is of interest to record that the identity of the plant has now been definitely established.

The seeds were first sent to the Imperial Institute in 1905 by Colonel E. J. E. Swayne, H.M. Commissioner in Somaliland, in order that their composition and probable nutritive value might be determined. The seeds were not known at Kew and the attempts to raise plants from them failed. Additional material has, however, been received recently at Kew from Somaliland through the present Commissioner, Captain H. E. S. Cordeaux, and from this the botanical identity of the plant has been determined. It proves to belong to the order Leguminosæ, but represents a hitherto unknown genus, which has been named Cordeauxia.

The plant has been described as *Cordeauxia edulis*, Hemsley (*Kew Bulletin*, 1907, p. 361, and Hooker's *Icones Plantarum*, xxix. tt. 2838, 2839).

Considerable interest attaches to these nuts on account of their high nutritive value as a food. It is desirable that the cultivation of this plant should be tried in other countries, especially where a food stuff is needed which can be grown in arid places, as appears to be the case with this plant in Somaliland.

Origanum Oil from Cyprus.—An account has been given already in this *Bulletin* (1906, **4**. 296) of the properties and chief characteristics of this essential oil, which is now being produced in considerable quantities in Cyprus. It was considered advisable to make a complete chemical examination of the oil, and this has been carried out in the laboratories of the Scientific and Technical Department of the Imperial Institute by Mr. S. S. Pickles, M.Sc., and the results communicated to the Chemical Society of London (*Journal of the Chemical Society*, 1908, **93**. p. 862).

The results show that the oil contains, as already mentioned in this *Bulletin* (*loc. cit.*), over 80 per cent. of carvacrol, and in addition small quantities of the hydrocarbon cymene and of a new terpene, which it is proposed to call origanene. There is also present a small amount of a terpineol possessing an odour recalling those of menthol and camphor. It will be seen that the principal constituent of the oil is carvacrol, and to this substance the oil owes mainly its characteristic thyme-like odour. Samples of this oil produced in Cyprus each year since 1904 have now been examined at the Imperial Institute, and the results show that the oil is remarkably constant in character, having usually a specific gravity of 0·964 to 0·966, being generally optically inactive, and soluble in 1·4 to 1·6 parts of 70 per cent. alcohol and containing 82·5 per cent. of carvacrol (by volume).

It was pointed out in the previous article in this *Bulletin* (*loc. cit.*) that this oil has the slight disadvantage of darkening considerably on exposure to light and air, but a method has now been worked out at the Imperial Institute of refining the oil so as to yield a product which will remain practically colourless for long periods, and it has been suggested that

practical trials of this refining process should be made in Cyprus, since it results in the production of an oil of greater value.

Ocimum viride from West Africa.—The "mosquito plant" (*Ocimum viride*) is held in repute both on the West Coast of Africa and in the West Indies as a protection against mosquitoes. A small quantity of the dried leaves of this plant was forwarded to the Imperial Institute from Northern Nigeria in September 1904, and on examination, the material was found to contain 1·2 per cent. of a volatile oil possessing a peculiar, thyme-like fragrance.

A larger consignment of the leaves was received from Sierra Leone in March 1907, and when distilled with steam yielded only 0·35 per cent. of the oil. An account of the properties and chemical composition of this oil has been given by Dr. E. Goulding and Mr. R. G. Pelly, of the Scientific Department of the Imperial Institute, in a paper published in the *Proceedings of the Chemical Society*, 1908, **24**. 63–64.

The oil is of an orange-yellow colour, has an aromatic thyme-like odour and a pungent, spicy taste. It is very mobile and is miscible with 90 per cent. alcohol in all proportions. The product has a specific gravity 0·9115 at 15° C. and an optical rotatory power of about $+1°30'$. The composition of the oil is approximately as follows:—Thymol, 32 per cent., alcohols (calculated as $C_{10}H_{18}O$), 40 per cent.; esters (calculated as $C_{10}H_{17}OAc$), 2 per cent.; the remainder consists chiefly of a terpene (or possibly a mixture of terpenes) $C_{10}H_{16}$, which is a mobile, highly refractive liquid of a pleasant, lemon-like odour, boiling at 160–166° C., with a specific gravity 0·8456 at 15°C. and an optical rotatory power $+0°10'$.

The great difference in the percentage yield of oil from the first sample compared with that from the later consignment may possibly be due to a difference in the time of year at which the leaves were collected in the two cases. It has, therefore, been suggested that small samples of the leaves should be collected at different seasons in order that this question may be investigated. After this point has been settled, it is hoped that a larger supply of the material may be obtained, so that a more complete examination of the oil and its constituents may be carried out. Now that its constituents are known it is possible that this oil may prove to be of commercial value.

Chlorocodon Roots from Uganda.—In October 1907 the dried roots of a species of Chlorocodon (probably *C. Whiteii*) were received at the Imperial Institute from Uganda, where the plant is known by the native name of "Murundo." This root has a pleasant, aromatic odour, resembling vanilla or heliotrope, and is said to be chewed by the natives for imparting fragrance to the breath.

The results of an investigation of the odorous constituent of this material by Dr. E. Goulding and Mr. R. G. Pelly, of the Scientific Department of the Imperial Institute, have been published recently in the *Proceedings of the Chemical Society*, 1908, **24**. 62–63. It has been found

that the powdered root, on distillation with steam, yields 0·5 per cent. of a white, crystalline substance, which possesses the characteristic odour of the root itself. This substance proves to be a new compound, the chemical composition of which is represented by the formula, $OMe.C_6H_3(OH).CHO$. It is therefore isomeric, although not identical, with vanillin.

Production of Prussic Acid by Rangoon Beans.—In continuation of the various articles on this subject, which have been published already in this *Bulletin* (1903, **1.** 15, 122, and 1905, **3.** 373), it may be mentioned that several samples of the "white" and "red" Rangoon beans now being sold in this country have been submitted to the Imperial Institute by the Board of Agriculture for examination, and the results of this work are published in a paper ("The poisonous properties of the Beans of *Phaseolus lunatus*") by Prof. Dunstan and Dr. Henry in a recent number of the *Journal of the Board of Agriculture* (1908, **14.** 722), and are also alluded to in a paper on "The occurrence of Cyanogenetic Glucosides in Feeding-stuffs" published by Drs. Henry and Auld in a recent number of the *Journal of the Society of Chemical Industry* (1908, **27.** 428). The results show that the white Rangoon beans at present on sale vary considerably in the amount of prussic acid they yield, some furnishing none or mere traces whilst from others as much as 0·26 per cent. may be obtained. It is also shown that the ordinary linseed cake of commerce contains some cyanogenetic glucoside (phaseolunatin), but that in the samples of this material examined at the Imperial Institute no active glucosidolytic enzyme was present and consequently the cake did not produce prussic acid when merely ground up in contact with water. The necessity for a series of feeding trials with materials containing small quantities of cyanogenetic glucosides in order to determine what precautions should be observed in using such products as feeding materials is pointed out.

Estimation of Orcinol in Orchella weed.—In connection with the examination of samples of orchella weed from the Seychelles (this *Bulletin*, p. 115) a new process for the estimation of orcinol in such products has been devised by Dr. Watt, of the Scientific Department of the Imperial Institute, and is described in a recent number of the *Journal of the Society of Chemical Industry* (1908, **27.** 612). The process is based on that of Stenhouse and depends on the extraction of the dye-yielding substance from the lichen by means of alkaline solutions and its subsequent oxidation with sodium hypochlorite.

Recent Developments in the Production of Camphor.—Several references have been made in previous numbers of this *Bulletin* to the cultivation and production of camphor (1905, **3.** 353, and 1907, **5.** 186), and as at the present time a considerable amount of interest is being shown in the subject by planters in British Colonies, the following additional notes bringing the information up to date have been compiled.

In a circular issued from the Royal Botanic Gardens of Ceylon

(1907, **4**. No. 3), Mr. J. K. Nock discusses the propagation of the camphor laurel (*Cinnamomum camphora*).

Five methods are available—(1) raising from seed; (2) layering; (3) branch cuttings; (4) root cuttings; or (5) suckers, and the precautions necessary in carrying out these operations are given.

Propagation from seed appears to have given the best results in Ceylon. The failure of the earlier attempts to raise camphor plants in this way is now found to have been due to the fact that the seeds rapidly lose their vitality, and will not germinate if stored for more than four or five months. Mature seed is available in Japan in November, so that in order to obtain fresh seed, applications should be made in September or October.

The high prices which have prevailed for camphor during the last few years, have stimulated the formation of camphor plantations in many localities. Plantations have been formed in the Federated Malay States, and in the United States experiments are proceeding in Michigan, Florida and California. Cultivation experiments are also being made by the Indian Forest Department in some districts in the Kanara range, where the plants appear to thrive well, and as the result of experiments conducted at the Biological-Agricultural Institute at Amani (this *Bulletin*, 1907, **5**. 186), the extensive cultivation of camphor in German East Africa has been advocated. Similar trials are said to be in progress in Algeria.

It is proposed also to extend the area of cultivation in Japan, and the great efforts now being made to complete the subjugation of Formosa will bring under the control of the Japanese Government a further large area of camphor-producing territory. In 1907 the production of camphor in Formosa was 5,388,918 lb. as against 4,040,838 lb. in 1906. Camphor is also receiving increased attention in China, and while the exports from Foochow in 1905 amounted to 4,805 cwt., valued at £43,039, this had risen in 1906 to 13,585 cwt., valued at £185,852.

The world's consumption of camphor in 1907 was estimated at about 10,600,000 lb., distributed in the following proportions per cent.:—celluloid manufacture, 70; explosives, 2; disinfectants and deodorisers, 15; medicinal preparations, 13.

The manufacture of "synthetic" camphor has also made rapid strides during the last two years, and at the present time factories in the United Kingdom, Germany, France, and the United States are making this product, which has for some time been available on the market, and it is probable that the recent considerable fall in the price of camphor is in some measure due to the competition of the synthetic product.

Fibre of Sida rhombifolia from India.—A sample of the fibre of *Sida rhombifolia*, known in the vernacular as "Barella," has been received recently from Bengal and examined in the Scientific and Technical Department. It consisted of soft, well-prepared, jute-like

fibre, of fine diameter, very good lustre, and fair strength, and was 4½ feet long. On chemical examination, it gave the following results:—

	Per cent.
Moisture	9·4
Ash	0·4
α-Hydrolysis (loss)	7·3
β-Hydrolysis (loss)	10·4
Acid purification (loss)	0·8
Cellulose	75·5

These results show that this fibre is of excellent quality. It compares very favourably with "extra fine" quality Indian jute, and could be utilised as a substitute for that fibre.

A sample was submitted to commercial experts, who described it as a beautiful specimen of fine, silky, well-grown fibre, very white in colour, free of root, strong and well-prepared. They stated that it could probably be used for mixing with silk, but even if only employed for the finest purposes to which jute is applied, it would sell very readily in large quantities at from £25 to £30 per ton (with "good" to "fine" jute at £16 to £25 per ton). The experts also stated that, in their opinion, the cultivation of this plant could be encouraged with advantage, as there would be a very good market for the fibre.

Sisal Hemp in German East Africa.—In the article on this subject printed in this *Bulletin* (1907, **5**. 422), two errata require correction. On page 424, in line 7 from the bottom, "a space of 4 × 10" should read "a space of 40 × 100," and in line 6 from the bottom on the same page, "about 310 acres" should read "about 380 acres."

Useful Plants of Madagascar.—In a pamphlet, entitled *Sur Quelques Plantes Utiles ou Intéressantes du Nord-Ouest de Madagascar*, issued by the Musée Colonial at Marseilles, M. H. Jumelle gives some interesting information regarding recently-discovered plants yielding products of economic importance in Madagascar. It has long been known that trees yielding a species of ebony occurred in the Island, and a small export trade in the product to Zanzibar and the East Indies, and also to Europe, has been in existence since 1894, but until quite recently the botanical origin of the wood was not known with certainty, though it had been suggested that like the "black woods" of Mauritius, Mozambique and Abyssinia, it was derived from species of *Diospyros*, possibly *D. haplostylis* and *D. microrhombus*, but M. Jumelle now shows that in the north-west of the Island at least, this wood is obtained from a new species, *D. Perrieri*, known by the natives as "lopingo." The tree is found chiefly on rocky soil in the deeper forests, or on the banks of rivers. Two other trees also yielding ebony-like woods, viz. *Dalbergia ikopensis* and *Dalbergia Perrieri*, Drake, are described (compare Jumelle, *Comptes Rendus*, February 1905, and Drake, *Histoire Natur. des*

plantes de Madagascar), the second of which yields on incision a curious fluid, which on drying furnishes a resinous substance, that it is thought may be suitable for use in the preparation of lacquers for metals. *Poupartia gummifera*, Sprague, a tree growing in rocky or sandy soil in dry woods, appears to yield nothing of economic importance, though, as its name implies, a "gum" is obtained from it. This "gum" is a mixture of true gum and resin, and appears to be incapable of industrial utilisation. *Stereospermum euphoroides* (native name "mangarahara") is a tree from thirty to ninety feet high, with a straight trunk of white, very hard wood, occurring on sandy soils in the dry forests. On scraping the trunk a soluble gum exudes, which in some respects resembles that from *Dalbergia Perrieri* mentioned above, but is not likely to be of any economic importance. *Ophiocaulon firingalavense*, Cast, is one of the passion-flowers, and, like other members of the same genus, has the lower part of its stem covered with a thick layer of a resinous excretion. A sample of this obtained by the author was greenish-brown in colour, and was largely soluble in such liquids as chloroform, alcohol, ether, or benzene, but insoluble in water. Other plants of interest mentioned in the pamphlet are *Genipa Rutenbergiana*, the flower buds of which are covered with a pleasant-smelling resin, which is collected by the natives and mixed with tallow for use as a pomade, and *Alafia Perrieri*, a creeper yielding a latex which is employed by the natives as a natural soap. Reference is also made to *Cryptostegia madagascariensis*, already well known as a rubber-yielding plant, but which is also used as a source of bark fibre, suitable for rope-making by the natives. In this respect it resembles the related plant, *Cryptostegia grandiflora* of India, from which both rubber and fibre are obtained (this *Bulletin*, 1907, **5**. 371). A second fibre-yielding plant dealt with is *Pachypodium Rutenbergianum*, from the bark of which a fibre is also obtained. It appears, however, that the last-mentioned plant is not sufficiently abundant in the Island to be worth exploiting as a source of fibre, even if on further trial this proves to be of commercial value. *Cryptostegia madagascariensis* is, however, considered worthy of attention both as a source of rubber and fibre.

In a second pamphlet, entitled *Notes sur la Flore du Nord-Ouest de Madagascar*, by MM. Jumelle and Perrier de la Bathie, also issued by the Musée Colonial de Marseille, a number of new species are described, of which the most interesting is a new species of *Khaya*, viz. *K. madagascariensis*, which yields, like *K. senegalensis* of West Africa, a red wood, of which small quantities have been exported to Havre. The trunk of the tree yields a water-soluble, slightly adhesive gum.

Agricultural Experiments in the Congo Free State.—A report on the progress of work at the agricultural station of Eala has been published as a supplement to the *Bulletin Officiel de l'Etat Independant du Congo* of January 1908. The station is composed of a botanical garden, an experimental garden, and a model farm.

In view of the great importance of manures in tropical countries, the subject of green manuring is receiving attention, and such plants as *Arachis hypogæa*, *Vigna catjang*, *Erythrina lithosperma*, *Albizzia moluccana*, etc., are being studied.

Various experiments are being carried on in the cultivation of the Ire rubber tree (*Funtumia elastica*), and details of the nature of growth and the yields of rubber on tapping when five or six years of age are given, although it is recommended that tapping should not be commenced till the seventh year. The method of coagulation of the latex, which has been found most satisfactory, is to heat to boiling with an equal bulk of water, care being taken not to boil too long, as this causes contamination of the rubber with resins. Several species of other rubber-yielding trees, and also balata and gutta-yielding trees, such as *Mimusops balata* and *Mimusops globosa*, *Palaquium oblongifolium* and *Payena Leerii*, are also being grown.

Two copal-yielding plants, *Copaifera Demeusei* and *Hymenæa verrucosa*, are being cultivated, but are only about eighteen inches high at present, and it will, therefore, be possible to observe the growth and the mode in which the copal is formed.

Tea, coffee and cocoa are being cultivated, and five samples of tea examined by Amsterdam experts were stated to be well grown but badly prepared, of unsatisfactory flavour and poor aroma, the best sample being valued at about 5*d.* per lb.

Among various plants yielding essential oils, *Ocimum viride* may be mentioned. A report on the examination at the Imperial Institute of oil from leaves of this plant grown in Sierra Leone is given in the present number of this *Bulletin*, p. 209.

Several plants which yield oil-seeds are being grown, but are as yet too young to bear fruit. Although vegetable dyestuffs are of less commercial importance now than formerly, *Bixa orellana* (see p. 171), *Randia cuvelieriana* and *Lawsonia alba* are being grown.

Among fibre plants are mentioned, *Musa textilis*, *Furcræa gigantea*, *Agave sisalana*, *Sansevieria guineensis* and *Sansevieria cylindrica*. These are awaiting the arrival of a decorticating machine; a sample of ramie grown and prepared at the station which was submitted to experts was stated by them not to be prepared in such a way as to be of commercial value.

In addition to the above, many plants yielding food grains, spices, drugs, fruits, forage and timber are also under investigation.

Land for Rubber Cultivation in British Guiana.—The Government of British Guiana has recently amended the conditions on which Crown Lands in the Colony will be leased for rubber cultivation, and the following summary of the revised regulations may be given for general information.

Leases will be granted for areas of any size for a term of 99 years free of rent for 10 years. At the end of 10 years the land may be

purchased at the rate of 4 dollars (16*s.* 8*d.*) per acre, if the conditions of the lease have been complied with, or may be rented at 20 cents (10*d.*) per acre per annum from the tenth to the fifteenth year, and afterwards at 50 cents (2*s.* 1*d.*) per acre per annum.

The lessee is required to plant rubber trees to an average of not less than 60 trees per acre, one twenty-fifth of the area being planted each year until ten twenty-fifths have been so planted.

Any rubber, balata, or other similar substance obtained on the land from indigenous or cultivated trees during the first 10 years of the lease shall be subject to a Government royalty of 2 cents (1*d.*) per lb.

Land suitable for rubber cultivation is available on all the large rivers and tributary streams, within easy communication of Georgetown, the chief city of the Colony.

The mean total annual rainfall in the districts most suitable for rubber cultivation is 96·57 inches, the maximum monthly record being 12·33 inches and the minimum 4·18 inches.

Copies of *The Official Gazette* of British Guiana giving full particulars regarding the granting of leases can be seen at the Imperial Institute. All applications for land must be addressed to the Commissioner of Lands and Mines, Georgetown, British Guiana.

Diatomaceous Earth in Ireland.—In the article on "Diatomaceous Earths and their Utilisation" published in this *Bulletin* (1905, **3.** 88–103), a deposit of diatomite found along the banks of the Bann river from Toome Bridge to Coleraine, should have been referred to as occurring in County Londonderry and not in County Down.

Geology of the Falkland Islands.—A recent number of the *Falkland Islands Magazine* contains a report of a lecture by Dr. Shottsberg of the Swedish Scientific Expedition, in which he gives a brief sketch of the geology of the islands, based on the observations of his colleague Mr. Halle, and of Dr. Anderson of the earlier Swedish Antarctic Expedition. The principal formations present appear to be, an ancient granite; Devonian sandstones, slates and quartzites; Permo-carboniferous beds with a Glossopteris flora similar to that of South Africa; and Quaternary deposits of very much later date.

Mineral Production of India during 1906.—This subject is dealt with by the Director of the Geological Survey of India in a recent number of the *Records* of the Survey (Vol. xxxvi., Part ii., p. 63). The total value of the mineral output rose from £5,689,948 in 1905 to £6,312,818 in 1906. Coal shows an increase from 8,552,422 tons to 9,940,246 tons, the most marked advance being in the Jherria field, which now takes first place. The export of coal exceeded a million tons.

Manganese shows an increase from 253,896 tons to 495,730 tons, so that the Indian output was larger than that of any other country.

The production of mica was nearly doubled. Other minerals which

showed a decided increase were precious stones, jadestone, tin ore, chromite and saltpetre. Petroleum for the first time showed a decrease, attributed to an arrangement between the Burma Oil Company and the producers in the Dutch East Indies. A diminished output of salt appears to be due to foreign competition. Gold also shows a decided falling off.

The output of iron ore for the Barakar works was reduced, but there was a considerable increase in the number of small native furnaces in the Central Provinces. Other items showing a decrease were graphite, magnesite, amber and tourmaline. The last mentioned mineral is mined in Burma for the Chinese market. It occurs in soft decomposed granitic veins.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

THE STRUCTURE OF THE COTTON FIBRE IN ITS RELATION TO TECHNICAL APPLICATION. By F. W. Bowman, D.Sc., F.R.S.E., F.L.S. Pp. xx. + 470, with numerous coloured and other illustrations. (London: Macmillan & Co., Ltd., 1908.)

Although the scope of this work is stated by the author to be limited to the enumeration of the distinctive characters of the cotton fibre, it has been found possible to include a good deal of useful information on the chemistry and dyeing of cotton, and the technical testing of fibres and yarns.

The earlier chapters are devoted to enumerating the sources of the various textile raw materials, and describing the apparatus and methods adopted in their investigation. After referring to the difficult question of the botanical origin of the cotton plant, a specially interesting account is given of the author's own observations on the gradual development of the fibre on the ripening seeds, prior to the opening of the cotton boll, and in this first part of the work useful data are given relating to the physical characters of cotton, particularly with regard to the variation in length and diameter of the cottons of commerce.

A considerable amount of space is devoted to consideration of the chemistry of cotton and cellulose, and the formation of cellulose during the growth of plant-cells; its composition and derivatives are fully discussed.

The results of a number of mechanical tests applied to single fibres and to yarns are enumerated in the chapters on testing, and a full discussion of the dyeing process, its effect on the structure of the cotton fibre, the penetration of dyestuffs into the fibre, and the dyeing of mercerised cotton is given. The final chapter deals with the usual

methods of examining fibrous products particularly with a view to the identification of their constituents microscopically, and by the use of stains and other reagents.

A few of the statements made require correction: thus New Zealand flax and sisal hemp should not be described as bast fibres, and the silk unwound in a continuous filament from a cocoon is wrongly said to form "the spun silk of commerce." In some cases the usual spelling of botanical names is not adhered to, and this is apt to lead to confusion.

The value of the book is greatly enhanced by the numerous illustrations, which are in most cases directly referred to in the text and clearly explained.

DIRECTORY OF PAPER-MAKERS, 1908. Pp. 212. (London: Marchant Singer & Co., 1908.)

In addition to alphabetical lists of the paper-makers of the United Kingdom, this directory gives the various trade designations used as watermarks, etc., in paper and stationery. It also contains a summary of the usual conventions and customs observed in the trade, and concludes with a classification of advertisers, which forms a useful directory of paper-makers, engineers and purveyors of raw materials and sundries. The work, like previous issues, will doubtless prove invaluable to all engaged in the paper-making industry.

CHAPTERS ON PAPER-MAKING. Vols. iii. and iv. By Clayton Beadle. Pp. viii. + 134; viii. + 156. (London: Crosby, Lockwood and Son, 1907.)

The first two volumes of this work have been noticed already in this *Bulletin* (1904, **2**. 212, and 1906, **4**. 74).

The third volume contains a discussion of such technical matters as boiling, bleaching, loading and colouring, whilst the fourth volume is devoted to questions of water supplies, the management of the paper machinery and the influence of the latter on the quality of papers.

These "chapters" will doubtless be of interest to all those engaged in the paper-making industry, and of special service to mill managers and operatives.

TEXTBOOK OF PAPER-MAKING. By C. F. Cross and E. J. Bevan. Third edition. Pp. 411, including plates and index. (London: E. and J. N. Spon, Ltd., 1907.)

The third edition of this well-known work on paper-making follows the lines of the two previous editions.

The nature and sources of the various raw materials and the methods employed for their conversion into paper occupy rather more than half the book, the remainder being devoted to chapters on the recovery of chemicals, qualities of papers, paper testing and analysis, statistics of production, etc. The important questions of the site and the water supply suitable for a paper mill are also discussed.

A chapter entitled "Special manufactures" deals briefly with such

materials as "paper yarns," and "Willesden" goods, which of late years have been the subjects of many patents. The last chapter consists of a useful bibliography.

In spite of its moderate size, the book treats the subject comprehensively, and the fact that it is now in its third edition is a sufficient indication that it has been found useful by those interested in paper-making.

TREES OF COMMERCE. By W. Stevenson. Revised Edition. Pp. viii. + 274. (London: William Rider & Sons, Ltd., 164, Aldersgate Street, E.C., 1908.)

This little book deals with upwards of fifty of the more important timbers of commerce, the object in view being to bring to the notice of those engaged in the trade some of the more prominent facts with regard to the botanical origin, physical properties and commercial history of timbers with which they deal. The subject matter was originally published in the *Timber Trades Journal*, and the first edition of the book dealt only with the commoner varieties of timber such as oak, ash, elm, maple, sycamore, and coniferous woods. In the revised edition, now under notice, some fifty pages dealing with the hardwood branch of the industry have been added, and in this section very useful information regarding the mahoganies, ebony, greenheart, the Australian eucalyptus timbers, teak, satinwood, etc., is to be found. The additional section adds much to the value of the book.

The author's method of treatment results in an unusually readable account of a subject notoriously difficult to deal with in even a semi-popular manner. The botanical origin of the timber is first discussed, and it is evident that considerable care has been taken in consulting the best authorities on this fundamentally important point, though it is probable that the results of recent work would allow of a more complete statement of the case in certain instances. The geographical distribution is then dealt with, and is followed by an account of the technical properties of the timber, reference being made to the more scientific investigations carried out by the experts attached to the Imperial Institute and by other authorities. In certain cases a short account of the commercial history of the timbers is given.

An unfortunate blemish in the new section on hardwoods is the somewhat frequent misspelling of botanical names. This is to be regretted, since the original edition was remarkably free from such errors.

LEATHER TRADES CHEMISTRY. By S. R. Trotman, M.A., F.I.C. Pp. x. + 290. (London: C. Griffin & Co., 1908.)

The title of this book is rather more comprehensive than its contents, which may be briefly stated to be a *résumé* of the methods available for the analysis of the materials utilised in the production of leather.

This volume would have been especially welcome a few years ago, since Professor Procter's *Leather Industries Laboratory Handbook*

was then out of print, and the author is a little unfortunate in that the present issue almost coincides with the publication of the new edition of Professor Procter's *Handbook*.

It is unnecessary to discuss in detail here the numerous branches of technical analysis which are necessarily touched upon, such as the examination of effluents, oils, soaps and glue, and the various substances used in the processes of unhairing, deliming, tanning and dressing of skins and hides, and it is sufficient to say that the information given on these matters is fairly complete and up to date, but special reference may be made to the section on the "analysis of tanning materials," which is particularly well done, and gives a useful *résumé* not only of the methods now in use, but also of those which have become more or less obsolete, and of the reasons which have led to their rejection.

The chapter on "common vegetable tannins" is properly devoted largely to sumac, which is probably the most generally adulterated tanning material, but no mention is made, for example, of wattle bark, a material of very wide application and one which is frequently stated to be sophisticated with barks of lower quality.

There are a few misprints and other slips of like character, such as "Schrotter" in place of Schrötter, and "Absorption of *tanning* by means of silk," the latter a peculiarly unfortunate one, as is also the indiscriminate use of the term "benzine" to describe both light petroleum and benzene. For example, "gas-tar benzine," "nitrobenzine," and finally the sentence "an ideal spirit would be one with a constant boiling-point of about 95° C. such as benzine, C_6H_6." It is a pity that the term benzine has become popular as a name for light petroleum, since it leads to confusion with the totally different substance benzene, but the initial mistake having been made it is the duty of authors of textbooks to make the difference clear to their readers. Apart from these defects, which are perhaps not very serious from the technical point of view, the book is well prepared, and its publication is welcome evidence of the greater tendency shown recently to apply science in the tanning industry.

KOKOSBUTTER UND ANDERE KUNSTSPEISEFETTE. By Louis Edgar Andés. Pp. vii. + 240, with 37 illustrations. (Vienna and Leipzig: A. Hartleben's Verlag, 1907.)

After giving an account of the origin and extraction of coconut oil, which, at the present time, is the only raw material used to any large extent in the manufacture of vegetable edible fats, the author proceeds to describe various methods of refining it and rendering it suitable for use. The chemical composition and constants of the fat are discussed, together with the methods of detecting adulterants. The processes employed in the conversion of coconut oil into butter-like products are described and several useful recipes are given. The manufacture of margarine is referred to, and methods are indicated for improving its properties. The work includes the preparation of various artificial

butters, artificial lards, and oils for cooking purposes, and descriptions are given of the machinery employed in their manufacture.

ALL ABOUT PEPPER. Second Edition. Pp. 94. (Colombo, Ceylon: A. M. and J. Ferguson, 1907.)

This is one of a series of planting manuals, well known to planters in the East, published by the Messrs. Ferguson of Colombo. The book is essentially a collection of articles on the cultivation and uses of pepper, taken from newspaper correspondence, Government reports and standard works of reference, such as the *Encyclopædia Britannica*, *Treasury of Botany*, etc.

Such a compilation, presenting all the information available regarding a product at the time of publication, is very useful, but its value would be greatly enhanced by a good index, which would facilitate reference. As it is, only a list of contents is provided, and the last five items in this refer the reader to the wrong pages.

ENCYCLOPÆDIA OF AGRICULTURE. Edited by C. E. Green and D. Young. Vol. i. "Aberdeen-Angus Cattle" to "Drains." Pp. xii. + 582. 1907. Vol. ii. "Drills" to "Joint-Ill." Pp. vii. + 536. 1908. (Edinburgh and London: William Green & Sons.)

This encyclopædia treats of agriculture, stock-keeping, forestry and gardening, and also of the arts and sciences in their bearing on the practice of farming, including law, book-keeping, building, veterinary medicine and surgery, agricultural chemistry, bacteriology, botany and entomology. Besides short articles describing matters that can be briefly explained, there are long articles by some forty-four different authors dealing with subjects with which they are specially acquainted. There are numerous full-page illustrations of the various breeds of live stock of the farm, together with smaller engravings in the text illustrating the descriptions.

FERTILISERS AND FEEDING STUFFS; THEIR PROPERTIES AND USES. By Bernard Dyer, D.Sc., F.I.C., Official Agricultural Analyst. With full text of the Fertilisers and Feeding Stuffs Act, 1906; the Regulations and Forms of the Board of Agriculture, and Notes on the Act. By A. J. David, B.A., LL.M., Barrister-at-Law. Fifth edition, revised. Pp. viii. + 150. (London: Crosby Lockwood & Son, 1908.)

This work is addressed to practical farmers, and is based both on the author's scientific knowledge and on the results of his personal observation and experience during many years of professional relations with farmers in England and Wales and whilst conducting the field experiments of the Essex Agricultural Society. The general functions of fertilisers are first dealt with, then follows an account of the manurial action of farmyard manure and of the various purchased fertilisers one by one, with a statement of the soils to which they are suited. Attention is drawn to the ease with which the valuable constituents of farmyard manure are lost by careless management, and directions are given for

avoiding this waste. The author estimates that the annual production of farmyard manure in the United Kingdom is some 40 million tons, worth at 5*s*. a ton £10,000,000, and that it would cost from £2,300,000 to £3,400,000 to replace by nitrate of soda the nitrogen that is lost from it by careless management. The crops of the farm are then considered, the manurial treatment best adapted to each is described and the reasons for it are explained.

The last two chapters deal with purchased feeding stuffs and the comparative value of foods. Not only the fattening properties of the foods must be taken into account, but also the manurial ingredients they add to the land of the farm, and it is pointed out that the market prices of feeding stuffs bear necessarily no direct ratio to their practical or intrinsic values, the most valuable foods being often low in price because their use is not sufficiently known to create a brisk demand for them; while foods of less intrinsic value may be dear because they are well known and widely used.

The Fertilisers and Feeding Stuffs Act of 1906, together with useful annotations on it, forms an Appendix to the work.

MINING MANUAL FOR 1908. By W. R. Skinner. Pp. xcvii. + 1406.

This work of reference maintains the high standard of previous years. It contains in a condensed form particulars of capital, mining rights, output and profits of practically every mining company in which British capital is invested, besides lists of directors and secretaries of mining companies, and mining engineers. It concludes with a glossary of mining terms.

DICTIONARY OF SPANISH AND SPANISH-AMERICAN MINING, METALLURGICAL AND ALLIED TERMS, TO WHICH SOME PORTUGUESE AND PORTUGUESE-AMERICAN (BRAZILIAN) TERMS ARE ADDED. By E. Halse, A.R.S.M. Pp. xiii. + 390. (London: C. Griffin & Co., Ltd., 1908.)

This is a useful work of reference for those interested in the mines in Spanish-speaking countries. It is quite as complete as could be expected, taking into account the variations in usage in different parts of South America. The author appears, however, to be unaware that in Bolivia the legua or league has been legally fixed at 5,000 metres, though there, as elsewhere, the distance popularly associated with the term is still very indefinite.

If Portuguese terms were inserted at all, they should have been given separately and at somewhat greater length. Brief notes for the pronunciation of the words of both languages would have been a very desirable addition.

SUR LA GENÈSE DE CERTAINS MINERALS D'ALUMINE ET DE FER. DÉCOMPOSITION LATÉRITIQUE. Par MM. Jean Chautard et Paul Lemoine. (Paris: Gauthier-Villars, Imprimeur-Libraire des Comptes Rendus des Séances de l'Academie de Science, 1908.)

The authors discuss the results of laterisation of certain diabase rocks on the coast of Guinea. They assume that the amount of titanium oxides remains constant, and thence deduce the loss which the rock has sustained. Lime, magnesia, and the alkalis have almost completely disappeared as well as a small portion of the alumina and rather more of the iron. Four-fifths of the silica is gone, and most of the remainder is in the free state. The alumina is retained as hydrargillite (Al_2O_3, $3\,H_2O$) and the iron as partly hydrated ferric oxide.

The facts are believed to be compatible with the operation of biological processes. Ores of iron and alumina result, and it is suggested that a similar process of enrichment in the case of rocks containing rare minerals may give rise to valuable deposits.

METEOROLOGICAL ATLAS OF THE INDIAN SEAS AND THE NORTH INDIAN OCEAN, prepared chiefly by W. L. Dallas, under the direction of Gilbert T. Walker, M.A., Sc.D., F.R.S. Pp. viii. + 39, with thirty-six charts. (Simla: Meteorological Department of the Government of India, 1908.)

The first twelve charts, which include the Arabian Sea, the Bay of Bengal and the Indian Ocean as far as latitude 10° S., show the normal distribution of pressure, the direction and force of the wind and the marine currents.

The nine charts that follow, and include the same area, show the tracks of storms in each month except in the first three months of the year in which no storms of any consequence occur. The direction of the path of a storm is usually either from south-east to north-west, or south-west to north-east, the former being much more common.

The last fifteen charts exhibit the cause and character of typical storms.

Besides the explanatory notes to the plates, there are diagrams of the storm signals at the different ports and directions for the reduction of the barometer at sea to standard conditions. The book will be of great value to all interested in Indian meteorology, and to navigators of the Indian Seas.

MURRAY'S HANDBOOK FOR EGYPT AND THE SUDAN. Edited by H. R. Hall, M.A., F.R.G.S. Eleventh edition; pp. i. to xiv., [1] to [170], 1 to 613, with fifty-eight maps and plans. (London: Edward Stanford, 1907.)

The issue of a new edition of this well-known handbook on Egypt has furnished the opportunity for a complete revision of the entire work at the hands of Mr. H. R. Hall, Assistant in the Department of Egyptian and Assyrian Antiquities at the British Museum, who has brought the book thoroughly up to date, and greatly enhanced its value as a source of information and guidance to travellers. The arrangement has been improved, and many of the descriptions have been largely extended, or entirely rewritten in the light of the most recent knowledge, prominence being given throughout to the antiquities of

the country. The revision has been mainly based on the personal observations of the editor, but other authorities have supplied information on special subjects, and the latest archæological and other works relating to the country have been freely consulted.

An introduction of 170 pages is devoted to an account of the country, its inhabitants, history, religion, archæology, etc., and also furnishes much information of a general character which will be useful to travellers. The detailed description of Egypt (pp. 1 to 541) is divided into six sections which deal respectively with (1) Alexandria, the Delta, and the Isthmus of Suez, (2) Cairo, its environs and the Pyramids, (3) the desert west of the Nile and the Fayyûm, (5) the Valley of the Nile from Cairo to Thebes, and (6) the Valley of the Nile from Luxor to Wadi Halfa. A section (pp. 542–585) on the Anglo-Egyptian Sudan makes its appearance for the first time in the *Handbook*.

The excellent maps and plans, some of which are new, are a special feature of the book, which is also provided with a useful index-directory.

In its new form the *Handbook* furnishes an efficient and trustworthy guide to Egypt and its antiquities, and should prove of great value to all visitors to the country.

THE WONDERFUL STORY OF UGANDA. By the Rev. J. D. Mullins, M.A. Second edition, with supplementary chapters by the Rev. C. D. Snell and the Rev. J. Roscoe. Pp. xii. + 235, with illustrations and maps. (London: Church Missionary Society, 1908.)

An interesting record of the development of Uganda, with special reference to missionary enterprise. In one of the supplementary chapters, a description is given of the industrial, educational and religious changes which have taken place since 1904, whilst the other contains a short account of the politics, manners, customs and beliefs of the Baganda. The work is provided with four appendices, which include chronological information on the history of Uganda, and a useful bibliography of the country, comprising works dealing with travel, geography and missions, books on the Luganda language, books written in that tongue and in Lunyoro, and a list of Blue-books and Parliamentary papers.

The volume has been carefully prepared, and is of interest not only as a record of missionary work, but also as a historical account of the civilisation, development, and progress of Uganda and its inhabitants.

CAPE COLONY TO-DAY. By A. R. E. Burton, F.R.G.S. Prepared under authority of the Cape Government Railway Department. Pp. viii. + 315. (Cape Town: Messrs. Townshend, Taylor & Snashall, 1908.)

The intention of this book is to place before the public interested in South Africa, more particularly intending emigrants and travellers, a readable account of the agricultural possibilities of Cape Colony and the advantages it offers as a touring ground.

The book consists of two parts. The first comprises a descriptive account of a series of ten selected tours over the Government Railways, each tour being well illustrated from excellent photographs, and provided with a bold, useful route map. The character of the country is described in detail, and much information is given concerning the agricultural and other industries. As regards the future prospects of the Colony, more especially from the agricultural point of view, the author would appear to be most optimistic, although the great and peculiar difficulties of the country are in no way minimised. In the second part a variety of subjects is dealt with, the most important being an account of the native races of the Cape, and a short, but very interesting, survey of the principal features of the South African flora, illustrated with useful outline drawings. The fauna, fishes and birds are also briefly described. The book concludes with an account of the services of the Cape Government Railways, and a railway map of South Africa is appended.

LIBRARY.—RECENT ADDITIONS

Books, etc., exclusive of Government Publications, presented to the Library of the Imperial Institute since February 26, 1908.

The Report of the Malta Chamber of Commerce, 1907	(*The Secretary.*)
Report on Tick, Redwater, or Texas Fever in Cattle (*Piroplasma bigeminum* or *P. bovis*); its cause, treatment and prevention	By Robert Wallace. (*The Author.*)
Report of the Committee of the Bengal Chamber of Commerce for the year 1906. With Appendices	(*The Secretary.*)
Report of the Ceylon Chamber of Commerce (Incorporated) for the half-year ended 31st December, 1907 . .	(*The Secretary.*)
Notes on the Patents and Designs Act, 1907	(*Messrs. Lloyd, Wise & Co.*)
Directory of Paper-makers, 1908 . .	(*Messrs. Marchant Singer & Co.*)
The Literary Yearbook for 1908 . .	(*Messrs. George Routledge & Sons, Ltd.*)
Modes of Occurrence of Canadian Graphite	By H. P. H. Brumell. (*The Author.*)
The Stock Exchange Official Intelligence for 1908	(*The Secretary.*)

Fauna of British India, including Ceylon and Burma: Coleoptera (Chrysomelidæ). Vol. i.	By Martin Jacoby. (*The Secretary of State for India.*)
Walch's Tasmanian Almanac for 1908 .	(*The Agent-General for Tasmania.*)
Yearbook of the Rubber Planters' Association of Mexico, 1907–1908	
A Botanic Station in Tropical Mexico .	By Helen Olsson-Seffer.
A Visit to some Botanic Gardens Abroad	By Dr. Pehr Olsson-Seffer. (*The Author.*)
The Fertility of Some Colonial Soils, as influenced by Geological Conditions .	By Chas. F. Juritz, M.A., F.I.C. (*The Author.*)
Une Nouvelle plante à Caoutchouc de Madagascar	By Henri Jumelle and H. Perrier de la Bathie.
Notes sur la Flore du Nord-ouest de Madagascar	By Henri Jumelle and H. Perrier de la Bathie.
Sur Quelques Plantes Utiles ou Interessantes du Nord-ouest de Madagascar .	By Henri Jumelle. (*Musée Colonial de Marseille.*)
Sands' Sydney, Suburban, and Country Commercial Directory for 1908. .	(*Messrs. John Sands, Ltd.*)
Jahresbericht der Deutschen Gerberschule zu Freiberg in Sachsen. Ostern 1907 bis Ostern 1908.	(*The Director.*)
Directory and Chronicle for China, Japan, Straits Settlements, Indo-China, Philippines, etc., 1908	("*The Hong Kong Daily Press.*")
Frontiers	By Lord Curzon. (*Oxford University Press.*)
Journal of the Royal Agricultural Society of England. Vol. lxviii. 1907. .	(*The Secretary.*)
Natal Directory for 1908 . . .	(*The Agent-General for Natal.*)
Report of the Singapore Chamber of Commerce and Exchange for the year 1907.	(*The Secretary.*)
Catalogue of the Library of the Royal Statistical Society, 1908	(*The President and Council.*)
Proceedings of the Royal Society of Edinburgh. Vol. xxvii., Part iii.. .	(*The Secretary.*)

Auckland University College Calendar, 1908	(*The Principal.*)
Trinidad and Tobago Yearbook, 1908 .	(*The Government Printer.*)
Memoires presentés a l'Institut Egyptien. Tome v., Fasc. ii.	(*Institut Egyptien.*)
Yearbook of the Planters' Association of Ceylon, 1904, 1905, and 1906 . .	(*The Secretary.*)
The Science Yearbook, with Astronomical, Physical and Chemical Tables, Summary of Progress in Science, Directory, Biographies and Diary for 1908 . .	Edited by Major B. F. S. Baden-Powell, F.R.G S., F.R. Met. Soc. (*The Editor.*)
The Ceylon Manual, comprising Historical, Statistical, and other information concerning the Island and its Administration	By Herbert White.
(Edited for the year 1908 by E. B. F. Sueter)	(*The Crown Agents for the Colonies.*)
Annual Report of the Yokohama Foreign Board of Trade for the year 1907, with Minutes of the Annual General Meeting, 1908	(*The Secretary.*)
The John Crerar Library: Thirteenth Annual Report	(*The Secretary.*)
Handbook of Jamaica for 1908 . .	(*The Crown Agents for the Colonies.*)
The National Physical Laboratory: Report for the year 1907 . . .	
The National Physical Laboratory: Collected Researches. Vols. iii. and iv. of 1908	(*The Director.*)
Transactions of the Highland and Agricultural Society of Scotland. Vol. xx. 1908	(*The Editor.*)
Documentary History of Education in Upper Canada (Ontario). Vol. xx. 1867–1869, Vol. xxii. 1869–1871 .	By J. George Hodgins, I.S.O., M.A., LL.D. (*The Minister of Education.*)
Metropolitan Borough of Battersea: Annual Report of the Council for the year ended 31st March, 1907. With Appendices	(*The Town Clerk.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1908. VOL. VI. NO. 3.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial and Indian Governments concerned.

TIMBERS FROM UGANDA.

THESE timbers were collected by Mr. Dawe, the Officer-in-Charge of the Forestry and Scientific Department, Uganda, in the course of a journey through the Protectorate, and were transmitted by him to the Imperial Institute for technical examination.

A report on eighteen timbers collected in the Mabira Forest, Uganda, has been published already in this *Bulletin* (1907, **5.** 122).

The collection of timbers now dealt with is of considerable interest, and includes the woods of several new species and genera. Specimens of most of the timbers have been placed on exhibition in the Uganda Court in the Public Galleries of the Imperial Institute.

The plants yielding the timbers were identified botanically at Kew by Mr. Dawe, from the herbarium specimens he collected, and the determinations were supplied by him to the Imperial Institute.

The specimens were not sufficiently large to enable mechanical tests to be made, but the working qualities of the timbers have been determined by Mr. Herbert Stone, F.L.S., Expert Referee to the Imperial Institute, who has furnished the following report:—

There is little that is remarkable in this series except the well-known African Blackwood, No. 793, which is already highly prized in European markets.

Four mahogany-like woods are included, namely, 351, *Carapa grandiflora;* 758, *Khaya anthotheca;* 786, *Pseudocedrela utilis*, and 358, *Pseudocedrela excelsa.* The first three of these are of marketable quality and worth attention; further search amongst trees of larger dimensions may result in the discovery of valuable timber. No. 564, *Faurea saligna*, a wood of great beauty, and the two species of Mlanje Cedar, Nos. 273 and 547, *Podocarpus milanjianus* and var., may all prove of value. Besides these there are some ten others, which are generally useful woods quite above the average.

The tests have been made with tools such as are commonly found in joiners' workshops, namely, circular saw, hand-plane, lathe, etc. The nail test is carried out as follows:—planks 1 inch thick are cut and ordinary 2 inch wire nails are driven in "across" at intervals of 1 inch, at 1 inch from the end. If the nails cannot be driven home the wood is said to "resist nails." If the wood splits the words "fissile" and "will not take nails" are used. Only those woods which are at all ornamental have been tested for polishing.

No. 119. *Garcinia Buchanani.* Baker.

A fine-grained wood of uniform brownish or reddish-white colour, not ornamental, nor of any export value, but an all round useful wood. Sapwood about 1 inch wide. Rather too hard for nails, but takes them without splitting; very hard to saw, but planes easily and well. It turns well, and takes a fairly good polish. Weight per cubic foot, 53¼ lb.

No. 229. *Xylopia Eminii.* Engler.

A wood of uniform brown or greyish colour, and of coarse, open grain. It is not ornamental, but may be useful for con-

struction. It takes nails well; saws very hard, but planes easily and well. It turns badly. Weight per cubic foot, 55½ lb.

No. 245. *Sideroxylon brevipes.* Baker.

A brownish-white wood of rather fine grain and uniform colour, with a dark-coloured sapwood about 1½ inches wide; not ornamental, but no doubt useful for construction in the Protectorate. It is hard, and resists nails, being fissile, and splits easily. It is very hard to saw; planes fairly easily and smoothly, and turns indifferently. Weight per cubic foot, 60 lb.

No. 247. *Unnamed.*

A reddish-brown wood of medium and open grain; sapwood about 2¼ inches thick. The specimen was somewhat unsound. The wood is rather ornamental, but has no export value, although it may be useful for construction. It takes nails fairly well, is rather hard to saw, and planes easily and well. It turns fairly well, and takes a good polish. Weight per cubic foot, 43 lb.

No. 248. *Ficus* sp. (native name "Mugwe").

A very coarse, open-grained wood of reddish colour; apparently a sapwood tree. The wood is not ornamental, and is of no export value. It will not take nails, being fissile; saws rather easily, and planes easily and smoothly. It turns indifferently. Weight per cubic foot, 40 lb.

No. 249. *Baikæa Eminii.* Taubert.

A wood of very coarse, open grain and uniform reddish colour; not ornamental; of no value for export, though probably useful for construction. It will not take nails, being fissile, but saws fairly easily, and planes easily and smoothly. It turns indifferently. Weight per cubic foot, 51 lb.

No. 250. *Mæsopsis berchemioides.* Engler. (Cf. No. 783.)

A dirty-white to pale-golden wood, with a metallic lustre, somewhat resembling No. 703; apparently a sapwood tree. It is coarse in the grain, rather soft, and takes nails well. It saws and planes fairly, but the grain rips out here and there. It turns well, and takes a good polish. Weight per cubic foot, 33½ lb.

No. 251. *Symphonia globulifera*, var. *africana*. Vesque.

A wood of poor quality and of yellowish-red, somewhat stripy colour, and coarse, open grain; sapwood about $1\frac{1}{2}$ inches wide. The wood is not ornamental, and is of no value for export, but will probably be useful for construction in the Protectorate. It will not take nails, being fissile, is rather hard to saw, but planes easily and smoothly. It turns badly. Weight per cubic foot, $43\frac{1}{2}$ lb.

No. 273. *Podocarpus milanjianus*, Rendle; var. *arborescens*, Fritz.

A fine, close-grained wood of uniform brown colour; apparently a sapwood tree. The specimen is knotty and curly, but if the quality averages as good as Mlanje Cedar from other localities, or as No. 547 of this series, it should readily find a market. It takes nails well, saws easily, and planes easily and smoothly. The specimen was too cross-grained for turning. Weight per cubic foot, $36\frac{1}{2}$ lb.

No. 293. *Sideroxylon* sp.

The specimen was unsound, but the wood appears to be of uniform, dull, reddish-brown colour, coarse and open-grained; apparently a sapwood tree. The wood is not ornamental, and is not of any export value, but possibly useful in the Protectorate for construction. It takes nails badly, being hard and fissile, is exceedingly hard to saw, but planes easily and well. It turns badly. Weight per cubic foot, $34\frac{1}{2}$ lb.

No. 294. *A Meliaceous wood, species unknown.*

A light-brown wood of uniform colour, and rather fine, open grain. It is fragrant when sawn, recalling sandal-wood. Sapwood about $1\frac{1}{2}$ inches wide. It is not ornamental, and of no value for export, but should be useful for construction in large pieces. It splits easily, and will not take nails on this account. It is excessively hard to saw, and in making the first cut plankwise through the specimen it was necessary to sharpen the saw (30 inch circular) three times. The wood is not hard, but there is evidently something in it which rapidly takes the cut off the saw.

It planes easily but badly, as the grain rips out. It turns fairly well, and takes a good polish. Weight per cubic foot, 56 lb.

No. 324. *Parinarium curatellæfolium.* Planch.

A wood of medium, open grain, and brownish-white colour; apparently a sapwood tree. It is not ornamental, and of no value for export, but it has the appearance of a generally useful wood. The specimen was too small for any proper tests; it is rather hard to saw, but planes smoothly.

No. 334. *Mimusops cuneifolia.* Baker.

A coarse-grained wood of uniform brownish colour; apparently a sapwood tree. It is not ornamental, and has no value for export, but may be a generally useful wood in the Protectorate. It splits when nails are driven into it, is rather hard to saw and plane, and the grain rips out. It turns fairly well, and takes a rather good polish. Weight per cubic foot, 63 lb.

No. 351. *Carapa grandiflora.* Spr. sp. nov.

A mahogany-like wood of medium open grain. Sapwood about 1½ inches wide. If the specimen is a fair sample it should find a market in competition with inferior Cedars and Baywoods. It is quite good enough for cigar boxes and the like, and no doubt will be used as a furniture wood in the Protectorate. It does not take nails, being fissile; it is hard to saw, but planes easily and smoothly. It turns easily and well, and takes a good polish. Weight per cubic foot, 37¾ lb.

No. 355. *Parinarium excelsum.* Sab.

A wood of light-brown colour and coarse, open grain; apparently a sapwood tree. It is not ornamental, and is of no value for export, but may be useful for furniture and the like in the Protectorate. It is hard, and resists nails; tough and hard to saw, planes fairly easily, but the grain rips out in places; it turns badly. Weight per cubic foot, 56 lb.

No. 358. *Pseudocedrela excelsa.* Dawe et Spr.

A mahogany-like wood of poor colour, being rather dull-brown. The specimen was too small for proper tests, but unless

better qualities can be found it is valueless for export. Weight per cubic foot, $35\frac{1}{4}$ lb.

No. 435. *Cola cordifolia.* K. Schum.

A greyish-brown wood with coarse and open grain. It is not ornamental, and is of no value for export, being an inferior wood. It is rather hard to saw, and planes easily, but the grain rips out. Weight per cubic foot, 39 lb.

No. 437. *Unnamed Sapotaceæous wood.*

A whitish, fine and close-grained wood; apparently a sap-wood tree. It is rather ornamental, but has no value for export. It should be a useful wood in the Protectorate. It will not take nails, being fissile; is hard to saw, but planes fairly easily and smoothly. It turns very well, and takes a good polish. Weight per cubic foot, 64 lb.

No. 441. *Pterygota* sp.

A very coarse, inferior wood of dirty-white colour. The specimen was too small for proper tests, but it is evident that the wood has little value. Weight per cubic foot, $43\frac{1}{2}$ lb.

No. 456. *Voacanga obtusa.* K. Schum.

A reddish-brown wood of fine and open grain; apparently a sapwood tree. It is not ornamental, and is of no value for export, but may be useful for construction. It takes nails rather well, though it is somewhat fissile. It is tough and hard to saw; planes easily but badly, as the grain rips out; it turns indifferently. Weight per cubic foot, $44\frac{1}{2}$ lb.

No. 479. *Toddalia nobilis.* Hook.

A dense, white wood, of poor quality, and fine close grain; apparently a sapwood tree. It is not ornamental, and is of no value for export. It will not take nails, being fissile, is hard to saw, and gives off a fish-like smell; planes easily, but the grain rips out very badly. It turns easily and smoothly. Weight per cubic foot, 58 lb.

No. 482. *Maba* sp., near *M. abyssinica.*

A wood of dirty-white colour, of no export value, and not by any means ornamental; apparently a sapwood tree. It is hard to saw, resists nails, planes fairly easily, but the grain rips out; it turns indifferently. The specimen is rough and curly, and judging from other species of the same genus it will not be a wood much used in construction. Weight per cubic foot, 52 lb.

No. 487. *Xanthoxylum* sp.

A coarse, open-grained wood, of dirty-white colour; of no export value, but possibly a useful wood in the Protectorate. It is apparently a sapwood tree. It takes nails well and saws firmly, although the specimen was somewhat unsound. It planes easily but badly, as the grain rips out. It turns easily, but does not finish well. Weight per cubic foot, 39 lb.

No. 491. *Unnamed.*

A hard, reddish wood, of rather fine and open grain; rather ornamental, but of no value for export. It will not take nails, being fissile. It is hard to saw and plane, and the grain rips out. The specimen is perhaps an exceptionally cross-grained piece. It turns fairly well, and takes a good polish. Weight per cubic foot, 57½ lb.

No. 492. *Cordia abyssinica.* R. Br.

A light-brown wood of medium, open grain. It is not ornamental, and has no export value. It is hard and resists nails; is difficult to saw, and though fairly easy to plane is difficult to smooth, as the grain rips out very badly. It turns indifferently. Sapwood 1½ to 1¾ inches thick. Weight per cubic foot, 69¼ lb.

No. 498. *Croton zambesicus.* Muell. (Cf. No. 13 of previous report, *loc. cit.*)

A rather coarse-grained wood of dirty-white colour; apparently a sapwood tree. The wood is of no ornamental or export value, but may be useful for construction. It takes nails easily, but splits; is tough, hard to saw, fairly easy to plane, but difficult to smooth. It turns badly. Weight per cubic foot, 44 lb.

No. 499. *Dactyopetalum ugandense.* Stapf, nov. sp.

A wood of dirty-white colour and medium, open grain; it is not ornamental, and of no value for export, but no doubt useful in the Protectorate; apparently a sapwood tree. It will not take nails, being fissile; is very hard to saw, and gives off an offensive smell. It planes easily, and fairly smooth, but the grain rips out a little. It turns fairly well. Weight per cubic foot, 44 lb.

No. 502. *Monodora myristica.* Dun.

A dirty-white wood of medium, open grain; apparently a sapwood tree. It is not ornamental, of no value for export, and is a doubtful wood altogether. It takes nails well, is firm, and saws fairly easily, planes easily and smoothly. It turns easily and well, and takes a fairly good polish. Weight per cubic foot, 36 lb.

No. 508. *Chrysophyllum albidum.* Dun.

A wood of dirty-brown colour, and very coarse, open grain; apparently a sapwood tree. It is not ornamental, and of no value for export, though it should be generally useful for construction in the Protectorate. It takes nails well, saws easily, planes easily, but is not easy to get smooth. It turns indifferently. Weight per cubic foot, 44½ lb.

No. 510. *Dawea ugandensis.* Spr.

A heavy, dense, fine, close-grained wood of a remarkable deep green colour. Sapwood about 3 inches thick. The specimen was too small for proper tests, but it is evidently a hard wood to work; it planes smoothly, with a very clean surface. It turns easily and extremely well, and takes a fairly good polish. Weight per cubic foot, 59 lb.

No. 513. *Alsodeia ilicifolia.* Wol.

A hard, dense, whitish wood, with a pretty pink silver grain, resembling coral. It can scarcely be said to be ornamental, and unless it has value as a turner's wood, is of no value for export. The specimen was too small for proper tests. Weight per cubic foot, 53 lb.

No. 525. *Cynometra Alexandri.* C. H. Wright.

A hard, heavy, dense wood of a stripy, brown colour, and fine, close grain. Sapwood $\frac{1}{4}$ inch to $\frac{1}{2}$ inch wide. It is rather ornamental, but of no export value. It resists nails and splits, saws very hard, and gives off a smell like burning fat. It is hard to plane, and the grain rips out. It turns fairly well, and takes a good polish. Weight per cubic foot, 65 lb. The curious odour of this wood when sawn appears to be due to the presence of traces of fatty acids.

No. 547. *Podocarpus milanjianus.* Rendle.

The specimen is of rather poor colour for this species, but otherwise it is a good wood, and should prove one of the most useful of the series. It resembles rather the yellow woods of the Cape than the cedar from Mlanje Mountain. It may be of value for export to the Cape, and possibly to Europe. The grain is fine and close. Apparently a sapwood tree. It does not take nails well, being fissile, and is difficult to smooth in consequence. It turns indifferently. Weight per cubic foot, $36\frac{3}{4}$ lb.

No. 549. *Ericinella Mannii.* Hook.

A dense, fine, close-grained wood of light-brown colour, much resembling pear wood, of doubtful value for export, but no doubt a very useful wood in the Protectorate. It takes nails fairly well, but is rather fissile. It is firm, saws easily, and planes comparatively easily and smoothly. It turns easily and well, and takes a very good polish. Weight per cubic foot, 49 lb.

No. 564. *Faurea saligna.* Oliv.

A very beautifully figured wood of medium, open grain, and uniform reddish-brown colour. Except for the difficulty of getting the wood smooth it might be said that the appearance of the wood would guarantee it a market. Unfortunately the flakes of silver-grain (medullary rays) in radial section tend to rip out during planing. It has 3 inches of dark-coloured sapwood. It takes nails well, is rather hard to saw and plane, turns fairly

easily, but is brittle, and takes a good polish. Weight per cubic foot, 58 lb.

No. 566. *Dombeya runsoroensis.* Schum.

A brownish-white wood of rather fine grain and uniform colour, with $1\frac{3}{4}$ inches to $2\frac{1}{2}$ inches of sapwood. It is no doubt a useful wood in the Protectorate, but of no use for export. It takes nails well, without splitting, is soft and light, yet tough; saws and planes easily, and is readily smoothed. It turns badly. Weight per cubic foot, $27\frac{1}{4}$ lb.

No. 611. *Unnamed.*

A coarse-grained, white wood, with a rather pretty figure; scarcely ornamental, and of doubtful export value, but may be useful for construction. It is apparently a sapwood tree. It is hard, and takes nails badly, being fissile; hard to saw and plane, and the grain rips out badly. It turns indifferently. Weight per cubic foot, 52 lb.

No. 637. *Ricinodendron africanum.* Mull. Arg.

This can scarcely be called a wood in the commercial sense, as it is so spongy and light. It can easily be torn by the finger-nail. The only use that can be suggested for it is for floats for rafting logs that are heavier than water. Weight per cubic foot, 12 lb. (Compare cork at 15 lb. per cubic foot.)

No. 689. *Chlorophora excelsa.* Bth. (Cf. No. 9 of previous report, *loc. cit.*)

A rather coarse-grained wood of uniform, yellowish colour, with pretty zigzag markings on a tangential section. It can scarcely be said to be ornamental, and is of little, if any, value for export. The heartwood is irregular in shape, and the sapwood from $1\frac{3}{4}$ to $2\frac{1}{4}$ inches thick. It is doubtless a useful wood for building purposes. It will not take nails, being fissile, is hard to saw, planes fairly easily, but the grain rips out; turns easily, but finishes badly. Weight per cubic foot, 46 lb.

No. 697. *Terminalia velutina.* Rolfe, nov. sp.

A hard, heavy, coarse, and open-grained wood, of light-brown colour, sometimes tinged with citron. It is not ornamental and

of doubtful value for export, but may be useful for construction. It resists nails, saws rather hard, planes easily, but the grain rips out badly; it also turns badly. Weight per cubic foot, 63 lb.

No. 703. *Unnamed.*

A lustrous brownish, pale-gold-coloured wood, with brown lines (the pores). It is rather ornamental, is light, soft, and works easily, but is of no value for export. In appearance it resembles certain species of Artocarpus. The grain is very coarse and open. It has 1½ inches to 2 inches of sapwood. Possibly the wood may be useful in Uganda, as it saws and planes easily though it tears up in places. It takes nails well, but is inclined to split; turns well and takes a good polish. Weight per cubic foot, 33½ lb.

No. 706. *Linociera* (?).

A rather fine-grained, compact, hard wood, of uniform light-brown, reddish or biscuit colour; apparently a sapwood tree. It is not ornamental, and of no export value, though useful for construction. It takes nails well, but they are hard to drive; is tough, hard to saw, planes fairly easily, but the wood rips out in places. It turns indifferently.

No. 733. *Unnamed.*

A reddish or brownish wood of uniform colour and medium open grain, with sapwood about 1 inch wide. It is rather ornamental, but of no export value, though no doubt useful in the Protectorate for construction. It will not take nails, being both hard and fissile, is hard to saw and plane, and the grain rips out; turns hard, but takes a good finish. Weight per cubic foot, 63 lb.

No. 755. *Celtis Soyauxii.* Eng. (Cf. No. 5 of previous report, *loc. cit.*)

A light-yellowish wood of rather fine grain and uniform colour. It is not ornamental, and of no export value, but may be useful in Uganda for rough purposes. It is tough, and hard to saw, planes rather hard, the wood rips out badly, and it is almost impossible to get it smooth. It takes nails badly, being fissile, and turns indifferently. Weight per cubic foot, 49½ lb.

No. 757. *Erythrophloeum guineense.* Don.

A very coarse, open-grained wood of brown colour, apparently a sapwood tree. It is not ornamental, and has no value for export, though it may be useful for construction. It will not take nails, being fissile, saws fairly easily, though firm and hard; planes easily, but the grain rips out badly. It turns indifferently. Weight per cubic foot, 63 lb.

No. 758. *Khaya anthotheca.* C. Dc.

A mahogany-like wood of light colour and weight, which would probably pass under the name of "Cedar" or "Baywood," and will probably find a market in England at a low price. It is possible that better qualities will be found to exist, so that further search should be made amongst larger trees. There is no distinction between the sapwood and heartwood. The grain is coarse, open and straight. It takes nails, and works well with all tools, but is a little troublesome to get smooth, as are other allied species. It polishes very well. Weight per cubic foot, $36\frac{1}{4}$ lb.

No. 783. *Mæsopsis berchemioides.* Eng. (Cf. No. 250.)

A soft, coarse, open-grained wood of uniform greenish-yellow colour, with a slight metallic lustre. Sapwood about 3 inches wide. It is scarcely ornamental, and is of doubtful value for export, but it should prove a useful wood in the Protectorate. It takes nails well, is tough, saws hard, planes fairly easily and smoothly, and turns indifferently. Weight per cubic foot, $27\frac{1}{2}$ lb.

No. 785. *Celtis* sp.

A very coarse, open-grained wood of greenish-yellow colour. Sapwood 2 inches to $2\frac{1}{2}$ inches. It can scarcely be called ornamental although the colour is striking; it is of no value for export. It will not take nails, being very fissile; is hard to saw and plane; the wood rips up in the most extraordinary way, it is quite impossible to plane it smooth. It turns badly. Weight per cubic foot, 49 lb.

No. 786. *Pseudocedrela utilis.* Dawe et Spr.

A mahogany-like wood of medium, open grain and fairly deep colour. In quality it is much the same as No. 351, and

may find a market as an inferior mahogany. Logs of better quality should be searched for. It will not take nails, being very fissile; is firm, saws and planes easily, but the grain rips out badly in places; turns well, and takes a good polish.

No. 788. *Balsamocitrus Dawei.* Stapf, nov. gen. in Rutaceæ.

A whitish wood with a citron-yellow tinge, of medium grain and uniform colour. It is not an ornamental wood, but should prove useful for construction in Uganda. It is hard, and takes nails badly in consequence, but does not split. It is of no value for export, though it has some resemblance to very inferior satin-wood. It is extremely hard to saw, planes hard and badly, the wood ripping out in places; turns well, and takes a good polish. Weight per cubic foot, 52¼ lb.

No. 793. *Dalbergia melanoxylon.* Guill.

This is the well-known "African blackwood," otherwise called "Cape Damson." It is a valuable substitute for ebony, to which it is in some respects superior. There is already a market for this wood in Europe, and if abundant it may be regarded as an important commercial product. It is extremely hard and heavy, but as it has very little sapwood (about ½ inch) there would be no necessity to dress it in Uganda. Its physical qualities are those of ebony. Weight per cubic foot, 78½ lb.

No. 798. *Cordia unyorensis.* Stapf, nov. sp.

A spongy, open and coarse-grained wood, of uniform yellow colour, and a slight metallic lustre; apparently a sapwood tree. It is scarcely ornamental, and of doubtful value for export, but probably useful in the Protectorate, especially for interior work. It is rather fissile, hence does not take nails very well; saws and planes easily, but the grain rips out a little; turns readily and well, and takes a good polish.

FIBRES FROM THE GOLD COAST.

SEVERAL specimens of fibres from the Gold Coast have been examined recently at the Imperial Institute, and a description of their properties, and the results of their investigation, are given in the following pages.

FIBRE OF *Sansevieria* sp. (probably *S. guineensis*).

This sample consisted of soft, clean, white, well-prepared fibre, which was fine, of good lustre, of fairly even diameter, and of good strength. The product was about 3 feet 9 inches long. On chemical examination it yielded the following results :—

	Per cent.
Moisture	10·3
Ash	0·2
α-Hydrolysis (loss)	8·8
β-Hydrolysis (loss)	10·5
Acid purification (loss)	1·4
Cellulose	81·8

The sample compared very favourably with other specimens of *Sansevieria guineensis* fibre examined at the Imperial Institute, the loss on hydrolysis being less and the percentage of cellulose higher. The fibre was of excellent quality and suitable for use with the finest Manila hemp; consignments of similar quality would be readily saleable at about £60 per ton.

PLANTAIN FIBRE (*Musa sapientum*).

This was a specimen of well-cleaned fibre which was brownish-white and of good lustre. The strands of fibre were uneven in diameter, this being a usual characteristic of fibres of *Musa* sp. The product was of fair, but very irregular strength, and about 4 feet long.

The results obtained on chemical examination were as follows :—

	Per cent.
Moisture	10·5
Ash	0·9
α-Hydrolysis (loss)	12·1
β-Hydrolysis (loss)	19·7
Acid purification (loss)	1·6
Cellulose	77·0

This sample of fibre was superior, so far as chemical composition and behaviour are concerned, to other specimens of *Musa sapientum* fibre previously examined at the Imperial Institute. It was very similar to the second quality of *Musa*

Ensete fibre from German East Africa (this *Bulletin*, 1905, **3**. 226), and was regarded by commercial experts as worth £40 per ton (with good Manila hemp at £38 to £42 per ton).

BANANA FIBRE (*Musa sapientum*).

This sample consisted of well-cleaned, brownish-white fibre, of good lustre, but uneven diameter and very irregular strength. The product was about 4 feet long.

On chemical examination it furnished the following results :—

	Per cent.
Moisture	10·1
Ash	0·8
α-Hydrolysis (loss)	13·0
β-Hydrolysis (loss)	20·7
Acid purification (loss)	1·3
Cellulose	74·0

This fibre was very similar to the preceding sample, and the same remarks are applicable to it. It was valued at £36 per ton (with fair Manila hemp at £35 to £36 per ton).

FIBRE OF *Triumfetta semitriloba*.

This was a specimen of soft, well-cleaned fibre, of pale buff colour, good lustre, fine and even diameter, and good strength. It was 5 feet long.

When submitted to chemical examination it gave the following results :—

	Per cent.
Moisture	10·3
Ash	0·8
α-Hydrolysis (loss)	7·3
β-Hydrolysis (loss)	10·4
Acid purification (loss)	0·6
Cellulose	73·5
Length of ultimate fibre	1·0–3·5 mm. (0·04–0·14 inch).

These results show that the fibre is somewhat similar to that of *Triumfetta rhomboidea*. It could be used for the same purposes as jute. The loss on hydrolysis is less than that

found for a sample of "extra fine" Indian jute, but on the other hand the percentage of cellulose is lower (see this *Bulletin*, 1905, **3**. 25). The fibre was regarded by commercial experts as worth £35 per ton (with finest Bengal jute at £35 to £40 per ton).

PINEAPPLE FIBRE (*Ananas sativus*).

This sample consisted of well-cleaned, soft, white fibre, somewhat lustrous, of even diameter and good strength, and about 3½ feet long.

On chemical examination it furnished the following results:—

	Per cent.
Moisture	9·5
Ash	1·1
α-Hydrolysis (loss)	13·7
β-Hydrolysis (loss)	19·4
Acid purification (loss)	1·7
Cellulose	81·5

This sample does not differ essentially from other specimens of pineapple fibre examined at the Imperial Institute, but the length of staple is perhaps above the average. Pineapple fibre does not come into the English market in regular quantities, but it might possibly be used as a flax substitute. The present specimen was considered as nominally worth £30 per ton.

KAPOK (*Eriodendron anfractuosum*).

This was a specimen of clean fibre, free from seeds, of dull greyish-brown colour and good lustre, soft and silky, but somewhat "felted" and not very resilient.

The fibres possessed the usual characteristics of kapok. They were from 0·8 inch to 1·1 inch long, and 0·0006 to 0·0011 inch in diameter, the average diameter being 0·0008 inch.

Kapok is used as an upholstery material, and is worth about 6*d.* per lb. if clean and of good colour. The value of the present sample would probably be not more than 4*d.* per lb. in London.

This sample was inferior in colour to good commercial kapok and was also less resilient. The condition of a portion of the sample suggested that it had been allowed to lie on the ground and become soiled and weather-beaten before being collected.

SEEDS OF *LOPHIRA ALATA* FROM SIERRA LEONE.

SUPPLIES of the seeds and fruits of this tree, which is widely distributed in Sierra Leone, and, indeed, through the coastal districts of West Africa, have been received recently at the Imperial Institute from Sierra Leone for examination as an oil seed, it being thought that the product is likely to be of some commercial importance since the seeds are obtainable in large quantities in readily accessible areas. The tree is already well known as one of the sources of the so-called African oak.

In all, five consignments of the seeds or fruits have been received for examination.

Fruits.

These are roughly conical and each consists of a reddish-brown, fibrous shell, usually about $\frac{1}{32}$ inch thick, enclosing a single seed or kernel. In many of the fruits received the kernels had undergone partial decomposition, and were dark brown, instead of almost white, internally.

Kernels.

These are conical in shape, about 1 inch in length, and $\frac{1}{2}$ inch broad at the base. Externally they vary in colour from orange-brown to, in a few cases, greenish-black. Internally they are almost white or pale-yellowish in colour when fresh, but tend to become brown when kept, and this darkening in colour seems as a rule to begin at the apex. They contain a semi-solid yellowish-white fat, and the amount of this present varied in the samples examined from 31·1 to 43·0 per cent., the variation being due apparently to three causes: viz. differences in (1) the maturity of the fruits when collected; (2) in their condition, as regards freshness, and (3) in dryness of the kernels examined.

Characters of the Fat.

Small quantities of the almost white or pale-yellow semi-solid fat present in the kernels were prepared from each of the products received, and these were chemically examined. The results obtained are given in the following tables:—

TABLE I.

Yield of Fat.

Mark of sample.	A.	B.	C.	D.	E.
Product received . . .	Fruits	Kernels	Fruits	Kernels	Kernels
Condition of kernels . .	Mostly sound	Good	Many partly decomposed	Good	Fairly good
Yield of fat (per cent. calculated on the weight of kernels used)	31·19	43·0	39·6	41·1	41·76

TABLE II.

Constants of Fat.

Mark of sample.	A.	B.	C.	D.	E.
Specific gravity at 40° C.	0·9105	0·9044	0·9044	0·9019	0·9016
Acid value	18·54	25·9	33·2	47·5	48
Saponification value . .	195·5	181·5	194·6	180·7	183·3
Iodine value	68·4	69·8	70·3	72·1	72·5
Reichert Meissl value .	—	0·9	0·9	0·8	0·8
Unsaponifiable matter .	1·49	0·5	—	—	0·86
Titer test	—	49·0	47·0	47·5	48·5

It will be noticed that the decorticated kernels are somewhat richer in oil than those which were exported in an undecorticated state, for the reasons already given. In the case of the last two samples of decorticated seeds the oils prepared from them are more rancid, as indicated by the higher acid values, than those obtained from the seeds exported in the shell, but the difference is not marked, and scarcely affects the commercial value of the oil. It is curious that the oils from the decorticated seeds have uniformly lower saponification values than the oils from the undecorticated seeds, but this difference is probably of little importance.

It is clear from these results that it will be advantageous to export the seeds in a decorticated state to save freight and the cost of decortication in Europe, and that so long as the decorticated seeds are thoroughly dried before export there is no likelihood that they will reach Europe in an unsatisfactory condition. Further, the results of the examination of sample E, which was stored in the Colony during two months of the rainy

season before shipment to this country, indicate that the kernels do not deteriorate much as the result of storage in a moist atmosphere. A portion of the consignment B was submitted to a firm of soap manufacturers in order that the oil might be expressed on a small commercial scale and tried for soap-making. This firm reported that they obtained from the decorticated seeds 43 per cent. of oil, which for their purposes would be worth from £1 to £2 per ton more than cotton-seed oil under ordinary market conditions. At present therefore the oil from *Lophira alata* would be worth from £24 to £25 per ton.

A small sample of the kernels was also submitted to a firm of oil seed crushers, who confirmed the above valuation of the oil, and valued the kernels provisionally at £10 per ton, c.i.f., Liverpool. It remains to be seen whether this price will, after paying for the collection of the fruits and their decortication in Sierra Leone, leave a margin large enough to induce traders to ship this product.

COPAL RESINS FROM BRITISH WEST AFRICA.

I. ACCRA COPAL.

A SAMPLE of copal resin from Ashanti was forwarded recently to the Imperial Institute by the Superintendent of Agriculture for the West African Colonies and Protectorates, for examination and valuation.

It weighed 650 grams, and was mostly in the form of yellowish-white, flattened tears, showing a glassy fracture when broken. In addition to the tears there were a few larger, irregularly shaped pieces which were not quite so clean.

The resin was transparent when scraped free from a thin, opaque layer which covered the surface. It was only sparingly soluble in turpentine oil or chloroform, but dissolved to the extent of about 75 per cent. in alcohol. Mixtures of equal parts of alcohol and benzene, and of alcohol and turpentine oil, dissolved practically the whole of the resin. In benzene the material was

almost insoluble, and in a mixture of ether and benzene it swelled up and was not totally soluble.

On chemical examination the copal furnished the following results, which are in general agreement with those obtained with former samples of Accra copal already described in this *Bulletin* (1907, **5**. 16), though the present sample is rather harder, as shown by its higher melting point:—

	Present Sample.	Previous Samples. 1	2	3
Ash, per cent.	0·1	2·21	0·12	0·5
Acid number*	124	134	133	126
Melting point	180°	145° C	120° C	128° C

* Milligrams of potash (KHO) required per gram of resin.

The price of Accra copal ranges from 34*s*. 6*d*. to 72*s*. per cwt. at the present time, and resin similar to this sample would probably realise the highest price if it were cleaned and the dirty pieces picked out before shipment.

Quite recently two pieces of copal resin from the Sekondi district of the Gold Coast were received for examination.

Description of Samples.

No. 1 consisted of a fairly clear mass, light-brown in colour with no weathered crust. It weighed 83 grams.

No. 2 consisted of a very rough, irregularly shaped, opaque mass, which was covered with a thin weathered crust and contained a small amount of woody matter. When fractured this sample was found to contain an appreciable amount of water. It weighed 158 grams.

Results of Examination.

A chemical examination of the powdered air-dried resins gave the following results:—

	No. 1.	No. 2.
Moisture	Slight gain in weight at 100° C	4·6 per cent.
Ash	0·2 per cent.	0·2 „ „
Acid number	133	133

The melting point of both samples was from 140° to 150° C.

The solubilities of the resins were as follows:—

Solvent.	No. 1.	No. 2.
Chloroform	partially soluble; swells up.	partially soluble; swells up.
Alcohol	almost completely soluble.	not quite so soluble as No. 1.
Ether	almost completely soluble	not quite so soluble as No. 1.
Turpentine oil	sparingly soluble.	sparingly soluble.
Turpentine oil and benzene	" "	" "
Turpentine oil and alcohol	completely soluble.	completely soluble.
Benzene	sparingly soluble.	sparingly soluble.

The loss of weight on "cleaning" sample No. 2 with alkaline liquids amounted to 20 per cent.

Commercial Valuation.

Samples of the resins were submitted to experts for commercial valuation.

No. 1 was reported to be of poor quality and only worth from 27*s.* 6*d.* to 30*s.* per cwt (May 1908).

No. 2 was reported to be a very good copal which would meet with a ready sale. If bulk consignments picked equal to this sample could be obtained they would be worth about 70*s.* per cwt., and even if mixed with small pieces the value would be from 40*s.* to 45*s.* per cwt (May 1908).

Botanical origin of Accra Copal.

The botanical origin of this resin has not been completely established, though it appears to be generally assumed that like Sierra Leone copal it is derived from a *Copaifera* sp. In the course of a tour in the Gold Coast Colony during the present year Mr. Dudgeon, the Superintendent of Agriculture for the West African Colonies and Protectorates, obtained from Captain

Armitage, Acting Chief Commissioner of Ashanti, specimens of the flowers and leaves of the copal tree of the North Ashanti forests; and with this material, supplemented by a sketch of the flowers made by Mr. Dudgeon, the authorities of Kew Gardens have been able to identify the tree as a *Cyanothyrsus* sp., thus bringing it into close relationship with Nigerian or Benin copal (see below).

II. SIERRA LEONE COPAL.

Two small supplies of this copal were received from Sierra Leone in 1906. It was stated that the samples represented two grades, and it was desired to ascertain the quality and value of each, and also for comparison the value of the material if ungraded.

Description.

Sample No. 1, labelled "Gum Copal, 1st grade," consisted of about 1½ lb. of the resin in tear-shaped lumps. It possessed a slight aromatic odour. The majority of the pieces were transparent and of a light-yellow colour, though occasional pieces of cloudy resin were also present; the tears were fairly free from enclosed foreign matter.

Sample No. 2, labelled "Gum Copal, 2nd grade," consisted of about ½ lb. of the resin. The tears were smaller than those of No. 1 and contained more foreign matter, chiefly of a vegetable nature, enclosed in the lumps. No. 2 also included several pieces (about 2 oz.) of a resin which appears to be quite distinct from ordinary Sierra Leone copal. The pieces were not homogeneous in colour, but varied from dirty-white to reddish-brown. When ground this material possessed a peculiar aromatic odour, quite different from that of the rest of the sample.

Results of Examination.

The samples were submitted to chemical examination and gave the following results, which agree generally with the figures recorded for Sierra Leone copal:—

	No. 1.	No. 2.	Foreign resin present in No. 2.
Ash, per cent.	0·04	0·20	0·59
Acid number	127	127	102
Melting point	137° C.	125° C.	145° C.

Both samples were partly soluble in alcohol, ether, chloroform, carbon disulphide or turpentine oil, and were completely dissolved by a mixture of alcohol and benzene.

The foreign resin present in sample No. 2 gave slightly different results on chemical examination, and was not entirely soluble in any mixture of solvents tried.

Commercial Valuation.

A commercial firm, to whom the samples were sent for valuation, reported that No. 1 was worth about 2*s.* 2*d.* per lb., and No. 2 (without separating the foreign resin) 1*s.* 9*d.* per lb. (June 1906). They stated that there is a good demand for such copal, and recommended shipments.

A second valuation was obtained from another firm who described sample No. 1 as very fine, clear copal, which would be worth 2*s.* 6*d.* per lb. In the case of No. 2 they separated the unknown material and valued the remainder at 1*s.* 11*d.* per lb. This firm also stated that the value of the two samples mixed together in about equal quantities would be about 2*s.* 2*d.* per lb. (June 1906).

Both samples were therefore of good quality, and it seems doubtful from the valuations received whether any great advantage would be obtained by grading such material before placing it on the market, though it would be advisable to reject the foreign resin present in No. 2 before shipment.

COPAL FROM SOUTHERN NIGERIA.

Some interest attaches to this product which has been placed on the market in considerable quantities in recent years. According to the Conservator of Forests for Southern Nigeria it is derived from *Cyanothyrsus Ogea*, Harms. (*Daniella oblonga*, Oliv.), and appears to be identical with "Ogea gum," of which small consignments formerly reached this country from time to time from West Africa.

A small sample of "Ogea gum" collected at Olokomeji in 1907 was received recently at the Imperial Institute from the Superintendent of Agriculture for the West African Colonies and Protectorates, and the opportunity has been taken to compare this with Nigerian copal of commerce. The "Ogea gum" was

in small fragments of yellow, glassy, copal-like resin, whilst the commercial sample of Nigerian copal, which was obtained in 1902, consisted of a single mass of glassy, pale-yellow resin, possessing a faint terebinthous odour when freshly broken. Both these samples were submitted to a preliminary examination and gave the following results :—

		Nigerian copal.	*Ogea gum.*	
Ash, per cent		0·0	0·5	
Acid number		110	116	
Melting point		180° C (approx.)	120° C (approx.)	
Solubility	Completely in	Mixture of alcohol and benzene Mixture of ether and benzene	Mixture of alcohol and benzene Mixture of alcohol and turpentine oil	Completely in
	Partially in	Chloroform Turpentine oil	Turpentine oil Alcohol	Partially in
	Almost insoluble in	Alcohol	—	

On comparing these results it will be seen that there is a general resemblance in the properties of the two resins and the differences noted, particularly the fact that the Nigerian copal is *nearly insoluble* in alcohol, whilst the "Ogea gum" is *partially* dissolved by that solvent, and that the former melts at a much higher temperature than the latter is perhaps to be accounted for by the greater age of the first sample, which as already indicated was obtained in 1902, since it is well known that resins of this type become less fusible and less readily soluble with age.

The present value of Nigerian copal is about 35*s.* per cwt.

RESIN OF *DANIELLA THURIFERA* FROM NORTHERN NIGERIA.

It has been stated frequently that *Daniella thurifera* is the source of the so-called West African or Illorin "balsam of copaiba" or "wood oil," of which considerable quantities have been imported in recent years into Europe, and which is commonly used by natives in West Africa as a substitute for true "balsam of copaiba." The statement has also been made that a copal is collected from the same tree.

The Superintendent of Agriculture for the West African Colonies and Protectorates has paid some attention to this point during a recent tour in Northern Nigeria, and has collected small samples of the oil and resin, and a herbarium specimen of

the tree, which have been received at the Imperial Institute for investigation. The herbarium specimen was submitted for identification to the Royal Gardens, Kew, where Dr. Stapf confirmed the view that the tree is *Daniella thurifera*, Oliv.

The samples received were as follows:—

No. 18. "Gum (copal?) exuded from the bark of *Daniella thurifera*."

This weighed 1·3 oz., and consisted of small, translucent yellowish fragments with some vegetable *débris*. The resin had a slight odour recalling that of mastic.

No. 19. "Tube containing remains of tapping wood oil from the same tree."

The contents of the tube consist of a semi-solid, almost black, sticky mass, with a terebinthous odour. It weighs about 0·25 oz. and is too small for examination.

No. 20. "Tube containing naturally exuded gum (copal?) from same tree."

This weighed about 0·12 oz. and consisted of small yellowish-brown granular fragments.

Samples 18 and 20 were submitted to a general examination and gave the following results:—

	No. 18.	No. 20.
Ash	Trace	1·2 per cent.
Acid number	97	132
Melting point	90° C. (approx.)	90° C. (approx.)
Solubility	Completely soluble in turpentine oil and mixture of alcohol and turpentine oil. Almost completely soluble in alcohol; mixture of alcohol and benzene.	Completely soluble in alcohol; mixture of alcohol and benzene; turpentine oil.

These results are of interest as showing that these two resins are quite different from the typical copals of commerce in melting at comparatively low temperatures and in being readily and practically completely soluble in the crude state in single organic solvents, such as alcohol or turpentine oil.

It seems likely that both these products are formed by the natural exudation of the "balsam" (oleo-resin), which then dries to resin on exposure to the air. It is of course possible that such resin on long exposure to air and moisture (fossil or semi-fossil resin) might yield a product which could be employed as

a copal, but these samples do not closely resemble in properties the various freshly-exuded resins which come on the market under the name of "recent" or "soft" copals.

AFRICAN ELEMI.

THE name "elemi" is in commerce practically restricted to the soft, aromatic oleo-resin collected in the Philippine Islands, from a species of Canarium, but from time to time small quantities of similar resins from other localities come on the market and are sold as "elemi," usually with the addition of a qualifying adjective to the name, which indicates the country of origin, and serves to distinguish them from the product of the Philippines. Thus the oleo-resin of *Dacroydes hexandra* is known as "West Indian or dry elemi" in this country, though in the West Indies it is better known as "gommier resin" (this *Bulletin*, 1904, **2.** 25). Similarly from various parts of West Africa, such as Liberia, Kamerun, Southern Nigeria, and elsewhere, small quantities of an aromatic oleo-resin are received from time to time under the name of "West African elemi." Recently samples of resins of this type have reached the Imperial Institute, both from West and East Africa, and it seems desirable to place on record the information available regarding products of this type.

Until quite recently the botanical origin of the true elemi of commerce was not known with certainty, but as the result of an investigation carried out by officials of the Bureau of Science, established in the Philippines, since these islands were annexed by the United States of America, it is now known that the oleo-resin is collected from *Canarium luzonicum* (Clover, *Phil. Journ. Sci.*, 1907, **2.** 2). The fresh oleo-resin contains from 25 to 30 per cent. of volatile oil composed mainly of hydrocarbons of which phellandrene forms by far the largest proportion. The non-volatile residue is of the nature of a resin, but, unlike these products in general, it is largely composed of readily crystallisable matter which can be separated into two well-defined substances, distinguished as α-amyrin and β-amyrin respectively.

At one time elemi was used in considerable quantities in medicine, as an ingredient in ointments and plasters, but this use has almost ceased, and at present it is mainly used in the preparation of printing inks, and occasionally as an ingredient in varnishes. The small demand which exists for elemi appears to be readily met by the supplies obtainable from the Philippines. At present good Manila elemi is worth from 50*s.* to 70*s.* per cwt.

Mention has already been made in this *Bulletin*, 1907, **5**. 186, of a sample of Liberian elemi, which was examined at the Imperial Institute, and supplementing that information the following results of the examination of samples from Southern Nigeria and Uganda may be given. At present nothing is known regarding the botanical source or sources of the elemi obtained in West Africa, and it would be of interest to have some information on this point.

ELEMI FROM SOUTHERN NIGERIA.

Two samples of this material have been received from Messrs. Alexander Miller Bros., of Liverpool.

No. 1 weighed about 4 lb., and was hard enough to retain its shape when cut into fragments. It was white or pale yellow in colour, with occasional patches of brown, and contained a good deal of vegetable *débris*.

No. 2 weighed about 2 ozs., and, like No. 1, was of firm consistence. It was yellowish-green in colour, and contained a small amount of woody matter.

On analysis the following results were obtained :—

	No. 1.	No. 2.
Ash	0·6	0·53
Acid number	55·3	37·8
Saponification number	71·9	46·2
Yield of volatile oil, per cent.	8·1	4·4
Solubility :—		
Completely soluble in	Benzene Turpentine oil * Turpentine oil + alcohol	Benzene Turpentine oil * Turpentine oil + alcohol
Sparingly soluble in	Cold alcohol	Cold alcohol

* *In this solvent the oleo-resin dissolves very slowly and not quite completely.*

From sample No. 1 a considerable quantity of the volatile oil was prepared by distillation with steam, and this had the following characters :—

	Characters of the oil from *W. African Elemi.*	Characters of the oil from *Manila Elemi.*
Colour	Pale straw yellow	Colourless or pale yellow
Specific gravity at 15° C. . .	0·8686	0·87 to 0·91 at 15° C.
Specific rotation in a 100 mm. tube	+ 50° 30′	+ 44° 3′
	Contains a large proportion of phellandrene	Contains phellandrene

UGANDA ELEMI FROM *CANARIUM SCHWEINFURTHII.*

This was forwarded for examination to the Imperial Institute in February of the present year.

The sample consisted of about 8 lb. of oleo-resin, varying in colour from white to pale yellow, and containing a considerable quantity of darker material mixed with woody matter. The whole sample had a dirty appearance, and the paler-coloured resin was only apparent when the sample was cut.

A chemical examination of the resin gave the following results :—

Ash (on average sample) per cent.	0·3	
Acid number	29·4	These constants were determined on a picked, clean portion of the oleo-resin.
Saponification number. . .	44·8	

The oleo-resin subjected to steam distillation gave 11·2 per cent. by weight of a pale straw-yellow essential oil, containing much phellandrene and having a specific gravity of 0·8451 at 15° C., and a rotation of +79° 20′ in a decimetre tube.

The qualitative solubilities of the oleo-resin were as follows :—

Alcohol	Sparingly soluble in the cold.
Turpentine oil	Slowly and not completely soluble.
Benzene	Readily and completely soluble.
Turpentine and alcohol .	Readily and completely soluble.
Benzene and alcohol .	Readily and completely soluble.

These data are sufficient to show that the Southern Nigeria and Uganda elemis present a general resemblance in properties to Manila elemi, the principal difference being in the smaller yield of volatile oil from the African kinds. It is probable that the African elemis, if carefully collected and stored so that they could be put on the market in a soft, clean condition, comparable with that of good qualities of Manila elemi, would be equally serviceable as ingredients in the manufacture of printing inks and varnishes; but, as already indicated, the total demand for elemi is small, and if large quantities of these products were put on the market they would probably be unsaleable.

CEARA RUBBER FROM PORTUGUESE EAST AFRICA.

THESE samples of Ceara rubber were prepared by Mr. W. H. Johnson, Director of Agriculture for the Companhia de Moçambique, in the course of his experimental tappings of Ceara trees at the Guara-Guara and Massanzane Estates Company's plantation in Portuguese East Africa, the details of which were given in the report previously published in this *Bulletin* (1907, **5**. 401).

Eleven samples of rubber, prepared by slightly different processes, were submitted for examination, and the following details were furnished regarding their preparation:—

No. 1 (2 biscuits).—A solution of 1 per cent. ammonia placed in collecting cups.

No. 2 (2 biscuits).—A solution of 2 per cent. ammonia placed in collecting cups.

No. 3 (3 biscuits).—A solution of 2 per cent. ammonia placed in collecting cups. 1 per cent. solution of creosote added to latex.

No. 4 (3 biscuits).—1 per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 5 (2 biscuits).—2 per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 6 (6 biscuits).—3 per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 7 (3 biscuits).—4 per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 8 (3 biscuits).—5 per cent. solution of formaldehyde placed in collecting cups. Rubber smoked.

No. 9 (2 biscuits).—Rubber smoked.

No. 10.—Smoked "scrap."

No. 11.—"Scrap."

The unsmoked biscuits, Nos. 1, 2, and 3, were very similar in appearance. They consisted of thin biscuits of pale brown rubber, rather rough and with white patches on the surface. The physical properties of all three samples were satisfactory.

The smoked specimens, Nos. 4, 5, 6, 7, 8 and 9, were also very similar in character. They were dark brown, but were otherwise superior in appearance to the unsmoked samples; they had a strong smoky odour. The physical properties of all the specimens were very satisfactory, and no differences could be detected between the samples prepared with varying amounts of formaldehyde.

The scrap rubbers, Nos. 10 and 11, were of good quality, the only difference being that the smoked sample, No. 10, was darker than the unsmoked scrap.

Results of Examination.

The following four samples, representative of the entire collection, were selected for analysis :—

No. 1.—1 per cent. solution of ammonia added to latex.

No. 3.—2 per cent. solution of ammonia and 1 per cent. solution of creosote added to latex.

No. 4.—1 per cent. solution of formaldehyde added to latex; rubber smoked.

No. 8.—5 per cent. solution of formaldehyde added to latex; rubber smoked.

The results of the examination of these samples are given in the following table :—

	Sample as received.				Composition of dry rubber.			
	No. 1.	No. 3.	No. 4.	No. 8.	No. 1.	No. 3.	No. 4.	No. 8.
Moisture, per cent. . .	1·9	2·9	0·6	1·7	—	—	—	—
Caoutchouc, per cent. .	82·9	80·5	85·1	83·1	84·4 *	82·8 *	85·6 *	84·6 *
Resin ,, ,, .	5·7	5·3	6·3	6·7	5·8	5·5	6·3	6·8
Proteids ,, ,, .	8·1	9·1	6·1	6·9	8·3	9·4	6·2	7·0
Ash ,, ,, .	1·4	2·2	1·9	1·6	1·5	2·3	1·9	1·6
* "*Caoutchouc*" *insoluble in chloroform*					1·0	1·6	0·7	0·2

It will be seen from a comparison of these figures that the four samples of Ceara rubber are fairly uniform in composition. The percentages of caoutchouc in the dry rubbers show little variation in the case of Nos. 1, 4 and 8; whilst the amount in No. 3 is only slightly lower than in the other samples owing to the presence of larger quantities of proteids and ash. All the specimens contained a small amount of "caoutchouc" insoluble or difficultly soluble in chloroform, the percentages of this constituent ranging from 0·2 in No. 8 to 1·6 in No. 3. The amounts of resin and ash vary a little in the different samples, but in no case are they excessive. The proteid figures are, however, a little high, especially in Nos. 1 and 3. It must be remembered, however, that ammonia was used in the preparation of samples Nos. 1 and 3, and this fact no doubt explains the higher percentage of nitrogen (from which the amount of proteid is calculated) found in these two cases. It may be noted further that No. 3, in which 2 per cent. ammonia was employed, gave a higher result than No. 1, where only 1 per cent. solution of ammonia was used. Except for this variation in the proteid figures there is little difference between the results obtained for Nos. 1 and 3, and similarly Nos. 4 and 8, prepared with 1 and 5 per cent. solution of formaldehyde respectively, show only slight variation in composition.

It was not stated whether these different samples of rubber were all prepared from a bulked quantity of latex, so as to permit of direct comparisons being made between the different methods of preparation employed, or whether the samples represent the product of the separate groups of trees. The variations in the analytical figures are, however, such as would be likely to occur in specimens prepared from different trees.

The results of the chemical examination of these four samples are satisfactory, and indicate that Ceara rubber of good quality can be prepared in the territory of the Mozambique Company.

For comparison with the results obtained in the examination of these samples of Ceara rubber from Portuguese East Africa, the following figures giving the composition of Ceara rubber produced in Ceylon may be quoted:—

	I.	II.	III.
Moisture, per cent.	0·70	3·10	1·58
Caoutchouc „ „	92·58	87·97	86·14
Resin „ „	3·80	1·40	5·74
Proteids „ „	2·12	6·13	5·06
Ash „ „	0·80	1·40	1·48

These Ceylon samples show striking differences in the percentages of resin and proteids, but all of them are slightly superior in composition to the specimens from Portuguese East Africa.

Commercial Value.

The following report on the commercial value of the samples in London has been furnished by brokers, and for comparison with the prices quoted it may be stated that fine hard Para rubber from South America was valued at 4*s.* 1*d.* per lb. on the same date, and fine plantation Para at 4*s.* 7*d.* to 4*s.* 8½*d.* per lb.

No. 1 (two biscuits cured by 1 per cent. ammonia solution in collecting cups).—Light and dark amber Ceara biscuits, rather rough, and a little stained.

No. 2 (two biscuits, 2 per cent. ammonia).—About the same as No. 1, but rather dull.

No. 3 (three biscuits, 2 per cent. ammonia and 1 per cent. solution of creosote).—Similar to above, but rather rough and scaly.

These three lots are of good quality and well prepared, there being very little to choose between them; if anything, No. 1 is rather the best. Value 4*s.* 6*d.* per lb.

No. 4 (three biscuits, 1 per cent. of formaldehyde).—Dark amber biscuits, good quality; one biscuit slightly deadish, not properly cured. Value 4*s.* 6*d.* per lb.

Nos. 5, 6, 7 and 8 (cured with 2, 3, 4 and 5 per cent. solution

of formaldehyde placed in collecting cups).—All good dark amber biscuits, well prepared; clear, clean and strong. Value 4*s.* 7*d.* per lb.

No. 9 (two biscuits, smoke cured).—A little rough, but apparently quite as good and well prepared as Nos. 5 to 8. Value 4*s.* 7*d.* per lb.

The smoked biscuits are better in appearance, and seem rather more resilient than the unsmoked. As to the effect on rubber of the use of ammonia and formaldehyde in various quantities, this would have to be determined by analysis, or on the reports of manufacturers, as the samples themselves show very little difference, whether mixed with 1 per cent. or 5 per cent.

No. 10.—Good clean brown smoked Scrap, free from heat, and well cured. Value 3*s.* 6*d.* per lb.

No. 11.—Pale Ceara Scrap, free from bark and heat, and of the usual quality of the grade. Value 3*s.* 4*d.* to 3*s.* 5*d.* per lb.

Conclusions.

It is evident from the results of this investigation that Ceara rubber of very satisfactory quality and value can be produced in Portuguese East Africa. It now remains to be ascertained whether the yield of rubber obtainable by the use of improved methods of tapping will render the cultivation of the trees remunerative.

RUBBER OF *FORSTERONIA FLORIBUNDA* FROM JAMAICA.

A SAMPLE of the rubber of *Forsteronia floribunda* prepared in Jamaica has been recently examined at the Imperial Institute.

The plant is stated to grow profusely in the limestone districts of Jamaica, and it was consequently desired to ascertain whether a market could be found for the rubber, and what its commercial value would be.

Description of Sample.

The sample, which weighed about 13 ounces, consisted of two small sheets and one larger cake of rubber. The sheets were dark-coloured throughout and quite dry, whereas the cake was

white and moist internally. The rubber was clean, free from stickiness, and exhibited satisfactory physical properties; it smelt strongly of creosote, which had no doubt been used in its preparation.

Results of Examination.

The rubber had the following composition :—

	Sample as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	10·8	—
Caoutchouc	79·3	88·8
Resin	6·3	7·1
Proteids	1·4	1·6
Insoluble matter	2·2	2·5
Ash	1·26	1·40

The analysis shows that the rubber is of good quality, the dry material containing nearly 89 per cent. of true rubber. The percentage of proteid is low, and the amount of resin not excessive.

Commercial Value.

The rubber was submitted for commercial valuation to brokers who reported that it would probably realise 2*s.* 4*d.* per lb. in London with fine hard Para from South America quoted at 3*s.* 5½*d.* per lb.

Conclusions.

The results of the examination of this sample of Forsteronia rubber confirm the conclusions drawn from previous investigations. There is no doubt that the rubber furnished by this vine is of good quality, and, if obtainable in quantity, it would be readily saleable. Up to the present time the absence of a regular and sufficient supply has been the principal hindrance to the commercial exploitation of the rubber from Forsteronia.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

THE CULTIVATION AND MARKETING OF MAIZE.

AMONG the food-grains of the world maize or Indian corn holds by no means an unimportant place; thus in the United States of America it occupies the leading position in agriculture, both as regards the area under cultivation and the amount produced. In 1907 the area under maize was just under 100 million acres; whilst that under wheat, the next crop as regards acreage, was only 45 million acres. The total production in that country was 2,592 million bushels, or, taking the U. S. A. bushel of maize as 56 lb., just under 65 million tons. Next after the United States, as a maize-producing country, comes the Argentine Republic, and then comes Hungary.

In the United Kingdom a comparatively small quantity of maize products is used as human food, yet the amount of maize imported for feeding poultry and farm live stock and for making spirits is quite considerable, as is shown by the following table; and in 1906 it averaged 125 lb. per head of the population.

Imports of Maize into the United Kingdom.

Year.	*Quantity in Tons.*	*Value in £.*
1898 . . .	2,858,465	11,282,310
1899 . . .	3,137,067	12,978,025
1900 . . .	2,707,578	12,327,859
1901 . . .	2,568,635	12,387,225
1902 . . .	2,224,649	11,713,132
1903 . . .	2,504,966	12,465,583
1904 . . .	2,144,894	10,247,134
1905 . . .	2,105,060	11,034,748
1906 . . .	2,434,260	11,972,694
1907 . . .	2,668,997	14,604,504

The United States of America and the Argentine Republic are the largest contributors to these imports, British Possessions rarely sending as much as ten per cent. of the total. There thus seems to be an opening for the development of a

much larger trade in maize from those colonies where the climate is suitable for its growth; and the object of the present article is to direct attention to this article of commerce, and especially to point out the precautions that should be taken in order that it may reach its destination without having undergone deterioration and consequent loss of market value.

The following table shows the sources and amounts of the imports during the three years 1905–7.

Imports of Maize into the Unitea Kingdom.

Origin	1905. *Tons.*	1906. *Tons.*	1907. *Tons.*
United States of America.	944,010	943,260	748,205
Argentine Republic . .	947,730	1,226,210	884,410
Other Foreign Countries .	23,712	149,990	889,340
British East Indies . .	45,885	1,190	1,655
Canada	137,040	106,110	117,930
Other British Possessions.	6,683	7,500	27,457
Total	2,105,060	2,434,260	2,668,997

As regards the extent to which maize is cultivated in different British possessions, the statistics from different localities vary much in respect to completeness and uniformity; but the following table gives some indication of the area devoted to its growth and the production obtained.

Maize.

	Area. Acres.	Estimated Production. Tons.	Year.
British India . . .	5,961,487	———	1904–5
Canada :—			
Ontario	289,456	———	1906
Quebec	28,506	———	1900
Manitoba . . .	6,246	———	1906
New Brunswick .	259	———	1900
Nova Scotia . .	177	———	1900
British Colombia .	51	———	1900
Prince Edward Island . .	37	———	1900
Total	324,732	———	

	Area. Acres.	Estimated Production. Tons.	Year.
Canada (Census of 1901) . . .	360,758	———	1900
Australia :—			
New South Wales	189,353	148,386	1905–6
Queensland . .	139,806	99,198	1906
Victoria	11,785	17,175	1905–6
Western Australia	43	12	1905–6
Total	340,987	264,771	
New Zealand . . .	10,485	16,961	1905–6
Natal	395,182	125,222	1905

The tropical and sub-tropical parts of Africa seem likely to prove very suitable localities for the growth of maize, and if the natives are encouraged to grow it in excess of their own needs, and bring it to market in good condition, the export trade should show a great development in the future. The following figures show that there are already signs of a developing industry in this grain in West Africa :—

Imports into the United Kingdom of Maize from British West Africa.

Year.	Gold Coast. Tons.	Lagos. Tons.	Nigerian Protectorates. Tons.
1902	0·5	2	—
1903	—	40	—
1904	95	3,035	—
1905	8	5,195	335
1906	—	7,100	400

The total exports of maize from Southern Nigeria in 1906 were 13,074 tons, valued at £37,386 ; of this 7,792 tons valued at £21,948 went to the United Kingdom. In the course of 1906 Lagos was amalgamated with and included in "Southern Nigeria," which explains the apparent discrepancy in the above sets of statistics. In 1907 the exports of maize from Southern Nigeria were 9,891 tons, valued at £28,521 ; of this 6,990 tons valued at £19,620 went to the United Kingdom.

Value of Maize exported from Southern Nigeria, including Lagos:—

Year.	£	Year	£
1900	193	1904	16,114
1901	320	1905	32,503
1902	161	1906	37,386
1903	2,215	1907	28,521

During the five years 1902–6, the imports into the United Kingdom from Australia, New Zealand, the Cape of Good Hope and Natal were intermittent and not very considerable—the largest annual import recorded being 1,475 tons from Australia in 1903; but now South Africa has entered the field as an exporter of maize to the United Kingdom, as the following table giving the exports for 1906 and 1907 shows:—

Exports of Maize from British South Africa.

Destination.	Via Cape Colony.				Via Natal.			
	Quantity.		Value.		Quantity.		Value.	
	1906. *Tons.*	1907. *Tons.*	1906. £	1907. £	1906. *Tons.*	1907. *Tons.*	1906. £	1907. £
United Kingdom	—	2,446	—	8,731	0·5	17,164	2	77,676
New South Wales	—	—	—	—	—	491	—	2,612
Victoria	—	513	—	3,434	—	—	—	—
Belgium	—	—	—	—	—	13,489	—	58,958
Germany	—	0·1	—	—	—	5,924	—	26,263
Holland	—	—	—	—	0·1	259	1	940
Canary Islands	—	—	—	—	—	826	—	3,955
Other places, excluding British S. African Colonies	45	133	349	879	423	120	2,501	765
Total	45	3,092	349	13,044	424	38,273	2,504	171,169

The exports via Beira and Delagoa Bay are not included in the above, but they only amounted to 6 tons in 1906, and 26 tons in 1907.

The prices in 1907 for mixed American maize, ex ship, ranged from 20*s.* to 29*s.* per 480 lb., and for La Plata maize, c.i.f., from 20*s.* 3*d.* to 28*s.* per 480 lb.

Maize (*Zea Mays*, Linn.) is the largest of the cereal plants, growing to a height of some 10 or 12 feet, but sometimes reaching 20 feet or more. The male flowers form a tassel at the top of the

stalk, whilst one or more spikes of female flowers are formed lower down, and when fertilised and ripened form the ears or cobs; these are compact cylinders some 6 to 9 inches long, composed of eight or more longitudinal rows of grains, yellow or white in colour, adhering to a fibrous core; the cylinders being covered with leaves forming a sheath or husk. Different varieties, however, vary greatly in their colour and dimensions.

Composition.—The grain of maize is covered with a smooth hard skin, inside which is the germ in juxtaposition to the main portion or endosperm, which is partly opaque white and partly translucent; the translucent portion being yellow in the yellow variety. The composition of the whole grain is as follows:—

	Per cent.
Moisture	10·75
Proteins	10·00
Oil	4·25
Starch, etc.	71·75
Fibre	1·75
Ash	1·50
	100·00

In various samples the percentage of proteins may vary from 4 below to 3 above the figure given above; that of the oil from $1\frac{1}{2}$ below to $4\frac{1}{2}$ above, and that of the starch, etc., from 9 below to $5\frac{1}{2}$ above.

The grain of maize does not differ much in its percentage composition from that of wheat, but the proteins (*i.e.* the nitrogenous substances or "flesh-formers") are largely "zeins," which do not yield the same elastic dough that the proteins of wheat and rye give, and consequently maize meal does not give such a satisfactory bread. To obviate this a proportion of wheat or rye flour is sometimes mixed with the maize meal for bread-making. Although maize yields inferior bread, many other satisfactory forms of food can be prepared from it by skilful cooking.

The whole grain is made up of 5·6 per cent. skin, 10·2 per cent. germ, and 84·2 per cent. endosperm, and these differ considerably in their composition.

Percentage Composition of Water-free Substance.

	Whole grain.	Skin.	Germ.	Endosperm.
Proteins .	12·7	6·6	21·7	12·2
Oil . .	4·3	1·6	29·6	1·5
Starch, etc. .	79·3	74·1	44·7	85·0
Fibre. .	2·0	16·4	2·9	0·6
Ash . .	1·7	1·3	1·1	0·7
	100·0	100·0	100·0	100·0

The proteins and oil are thus concentrated in the germ, the fibre in the skin, and the starch in the endosperm.

In the process of milling the grain is usually first kiln-dried, which facilitates the separation of the skin and lessens the vitality of moulds; the skin and germ are then separated, and the endosperm is ground into products of varying degrees of fineness. The offal amounts to from 30 to 35 per cent. of the weight of the whole grain. The separated germs are submitted to hydraulic pressure to obtain the oil they contain; very large quantities of this are produced in the United States, and it is used as an edible oil and for making margarine and soft soap. Other products manufactured from maize are starch, glucose, and an alcoholic drink known as "Bourbon whisky."

Varieties.—The varieties of the maize plant are very numerous, several hundreds having been recorded, and the differences between them are also great: thus as regards height they vary from 18 inches to 20 feet or more; in length of cob from 1 to 16 inches; in the number of rows on the cob from 8 to 24; and in individual cobs from 4 to 48; the grains may weigh from 46 to 1530 grains weight per 100; the time taken to ripen may be from 1 to 7 months; and cobs of other colours besides white and yellow are known.

The different varieties have been divided into seven classes according to the nature of their grains, namely:—

1. The pod corns: these are curious varieties in which each grain is enclosed in a pod or husk; these are perhaps the original form of the plant.

2. The pop corns: in these the cob and grains are small, and the endosperm is mostly horny and translucent, there being

little or no opaque starchy portion; when heated over a fire they burst, with the formation of a white starchy mass, which is eaten as a sweetmeat.

3. The flint corns: in these the starchy portion of the endosperm is enclosed in the horny portion.

4. The dent corns: in these the starchy portion of the endosperm is not enclosed by the horny portion, but reaches to the summit of the grain, and the horny portion is at the sides; as the starchy portion shrinks in drying, the summit of the grain is drawn in and an indentation is produced.

5. The soft corns: in these the endosperm is all starchy, and there is no horny portion.

6. The sweet corns: these are characterised by the translucent horny appearance of the grains, and by the latter having a more or less wrinkled or shrivelled condition.

7. The starchy sweet corns: in these the grain externally resembles sweet corn, but the lower half is starchy.

Climate.—Maize requires a high summer temperature and abundant moisture, and attains its most luxuriant growth where the summer is long continued, reaching a height of 20 feet and more; but certain varieties of it are adapted to take advantage of a short but hot summer, and ripen in more northern latitudes; these, however, do not attain nearly so great a height. It is grown in Southern Europe, especially in Hungary, Roumania and Italy, in the southern parts of Asia, in Africa, in Australia, especially in New South Wales and Queensland, and in America, from Canada to Patagonia. Frost kills the plant in all its stages, and the crop does not flourish well if the nights are cool. In the tropics it can be grown from the sea-level to considerable altitudes. In cool localities it will not ripen, though it can be grown for use as fodder.

Soil.—The best soil for maize is a rich sandy loam containing a fair amount of humus, well drained, but holding moisture well, since the plant makes a rapid and succulent growth; for this reason the presence of humus is important, owing to its retentive power for moisture. Stiff clay is prejudicial. Maize grows well in succession to crops which leave behind them plenty of vegetable matter to form humus; any land which has given a good crop of hay will after ploughing give a good crop of maize.

Leguminous plants form good crops to precede maize, as they enrich the soil in humus and nitrogenous matter.

Seed Selection.—In order to ensure a good growth in the next crop the seed for sowing should be selected in the field, and not after gathering, as the character of the stalk a cob came from cannot then be known; the best cobs of the best stalks should be collected and kept apart to furnish seed. In the Southern United States stalks producing two cobs to the stalk are preferred, as they are considered to give the largest yields. Cobs poor in size, shape or fulness should be rejected, and if one cob on a stalk is very poor both should be rejected. A cob that bends over in ripening so that the top hangs downwards is advantageous, as the rain does not collect at the bottom and cause decay or sprouting.

The ears should be of good size, of nearly uniform diameter throughout, and well filled at both ends. The individual grains should be long, and so broad at the upper end as to leave only a slight depression between the rows.

When a satisfactory kind of maize has been found, care should be taken not to plant another kind of maize anywhere near it, as the pollen from the tassels is carried by the wind and fertilises cobs at a distance, and thus the character of the good maize would be altered in the next crop.

Planting and Cultivation.—In places where water is liable to stand after heavy rains the land should be ploughed so as to form beds on which to plant the maize, but where the surface water runs off quickly the land should be ploughed flat. With good drainage flat planting is the best, as it is less expensive, and the amount of surface exposed being smaller there is less evaporation, and the crop therefore stands drought better. When beds are made they may be 4 feet or 8 feet wide; in the latter case the maize is planted in two rows, one near each edge of the bed with 4 feet between the rows; the surplus water then drains into the furrows between the beds. After ploughing the soil should be well pulverised by harrowing; a thorough preparation of the soil produces a better crop and facilitates subsequent operations in destroying weeds.

Maize is commonly planted in rows 4 feet apart, as this allows a convenient width for cultivating between the plants;

the distance between the plants in the row is about 3 feet, but the thickness of planting must be varied according to circumstances, both the fertility of the land and the amount of moisture being considered. On very fertile soils distances of $3\frac{1}{2}$ feet $\times$ $3\frac{1}{2}$ feet with 3 grains per hill are adopted. The richer the soil the closer can planting be done with safety. If the stalks stand too thickly in the rows the crop will suffer more in dry weather than when planted more thinly, and when the plants crowd each other they do not produce good ears, whilst more leaf is the result.

Planting should be deferred until the soil has become warm enough to ensure prompt germination of the seed; the depth at which the seed should be sown depends on the temperature and moisture of the soil; if it is planted at too great a depth the soil is cold and wet, and the seed may decay; if it is too near the surface of a dry soil, and dry weather continues, the crop may prove uneven. The planting is done either by means of a horse-drawn planting machine or the seed is dropped on the surface and covered by using a hoe.

Cultivation should begin immediately after the first rain that follows the planting; the surface should be broken and the weeds killed, and this should be repeated after each rain, so as to prevent the formation of a crust and to kill the weeds. When the crop is from 4 to 6 inches high it should be hoed and thinned to the proper number of stalks, as it will then be past the greatest danger from insect attack, and any weeds growing in the rows between the stalks should be cut out. In times of drought a well pulverised but shallow surface layer forming a "dust mulch" checks evaporation and keeps the soil beneath moist.

Harvesting.—When matured the ears of maize or cobs, sometimes with a good proportion of the husks attached, are pulled by hand from the stalks; the latter are then utilised by allowing stock to feed on them in the field, or are cut and made into fodder by a shredding machine; the plan of making them into silage for milch cows is also sometimes practised. It is sometimes thought that if the cobs are stored with the husks on, the latter protect them from insect attack, but this idea does not seem well founded, and it is usually best to remove the husks

at the time of gathering. Horse-drawn machines are sometimes used to cut and bind the maize crop, and the cobs are subsequently removed from the shocks in the field. Machines for gathering the ears from the standing stalks, husking them and delivering them into wagons have also been designed and used to some extent.

The grain is removed from the cob by machines known as corn-shellers. Several types of the latter are supplied by Messrs. Peter Henderson & Co., of New York, namely: (1) the "Burrall Corn-sheller," which can be worked by one man: it shells 100 bushels a day, and costs $6·75; (2) the "Clinton Corn-sheller": this costs $4·50 with one balance-wheel, and $5·50 with two balance-wheels; it does not separate the grain from the stripped cob; (3) the "Black Hawk Corn-sheller": this is a small hand-machine, costing $2. Messrs. Ruston, Proctor & Co., of Lincoln, England, supply an "Improved Maize Husking, Shelling and Dressing Machine." In this the cobs fall upon a revolving drum, which strips off the grain. The grain is cleaned from dust, loose husk and other refuse, by riddles and by a strong current of air, and is elevated to the sack-spouts in a finished condition. The machine, which is provided with a portable feed-elevator, is made in two sizes: (1) the 3 feet 6 inch machine, shelling and dressing about 400 quarters of maize in 10 hours, and requiring a 6 horse-power portable engine to drive it; (2) the 5 feet machine, shelling and dressing about 850 to 900 quarters in 10 hours, and requiring a 10 horse-power portable engine to drive it. In the case of both machines, if husking is done at the same time, the output will be about half the quantities named above.

If the machine employed for shelling has furnished the maize in an imperfectly cleaned condition, a separate cleaning operation to remove the "fluff" should be given before shipment, as the latter increases the risk of the grain heating on the voyage.

As regards yield, the average annual amount per acre in the United States was 25·9 bushels in 1907, and in the forty-two years 1866–1907, the range was from 16·7 bushels in 1901 to 30·8 bushels in 1872. As regards maximum yields, over 100 bushels per acre has been recorded in some cases in the United States.

Storage and Transport.—During storage, and during transport from the place of growth to the United Kingdom, maize is liable to suffer a considerable amount of deterioration from two causes, namely, fermentation and insect attacks. When maize coming from West Africa suffers, the damage is mostly due to the attacks of weevils, whilst the principal defect that occurs in that coming from the United States and the Argentine Republic is due to the effects of heating on the voyage caused by fermentation induced by the excessive amount of moisture it sometimes contains; the quality and value may be seriously diminished by this cause.

Soon after maturity maize may contain as much as 20 to 22 per cent. of moisture; if it is stored in this state, without an opportunity of getting drier, it may escape damage in cold winter weather, but as soon as warm weather comes fermentation will occur and the grain will be damaged. If it is left on the cob and stored in well-ventilated "cribs" until the late winter or spring it will usually get sufficiently dry. In the Argentine Republic the cribs used for storing maize are made of poles stuck into the ground, with wire and maize stalks woven in among them so as to form a sort of bin; in this the cobs are put, and the walls being more or less open, allow air to circulate through the contents, and the maize dries, especially if the crib is thatched over to keep out the rain. If by the time warm weather arrives the moisture has been reduced to 12 or 13 per cent., the maize under ordinary conditions can be stored or transported with safety, but if the maize has not been sufficiently dried some more artificial method must be adopted.

One of these methods employed in modern grain storehouses is to transfer grain from one bin to another by means of transfer belts and elevators; during this operation the circulation of the air effects a certain amount of drying, and the process is frequently employed to keep grain in good condition. In the case of maize, however, if the transfer is made too frequently many of the grains get broken, and besides, the operation is somewhat expensive. Another method known as "kiln drying" has been devised; in this heated air is passed through the maize until the superfluous moisture is removed. It is stated by some that the heat injures the maize for manufacturing purposes, and that

the kiln-dried maize is liable to suffer considerable damage by cracking and breaking during subsequent handling operations; the objection to kiln drying, however, may partly have arisen from badly damaged material having sometimes been treated and mixed with better grades. There seems no reason why, either by using a lower temperature for the air and prolonging the time of drying, or by using air previously deprived of its moisture by refrigeration, and then warmed, some suitable method of drying maize should not be attained.

An alternative plan to storing in a ventilated crib is to allow the maize to dry thoroughly before storing, and then to keep it in a tightly closed bin in which it can be treated to destroy insects; in some climates the slow drying in the ventilated crib would not be successful.

Having regard to the injury caused by dampness it is important that the grain should not be exposed to rain in the course of transport by land, warehousing and shipping, nor to damp air during the voyage; and the stores should be dry and thoroughly well ventilated, and be kept clean and whitewashed.

Among the insect enemies of maize weevils cause an immense amount of damage, especially to that coming from West Africa; it seems probable that the chief source of infection is the warehouse where the maize is collected before shipment, though the attack may commence at the country farms, and some of these insects may be lurking in the holds of the steamers that convey the maize to England. The larvæ of some moths also attack the grain.

Weevils and moths can be easily killed by the use of carbon bisulphide, a colourless volatile liquid which gives off a heavy vapour, but its use in tropical countries will require careful supervision owing to its poisonous properties and great inflammability. It may be applied either by spraying or pouring the liquid over the grain, but it is commonly put in shallow pans placed above the grain; from these it evaporates, and the heavy vapour sinking through the grain kills the insects. The best results are obtained when the grain is stored in air-tight bins or closed tanks; but in absence of these, covering the grain with tarpaulins, oil cloths, or canvas sails will be found effective. It is often a good plan to build a "quarantine bin," in which the

grain is treated and afterwards removed to the store. The carbon bisulphide is used at the rate of 1 lb. to each 100 bushels of grain, and is allowed to act for from 24 to 48 hours.

Buildings can sometimes be treated with this substance, using 1 lb. of the liquid for 1000 cubic feet of space, and placing it high up so that the vapour may descend; apertures should be closed and the building kept shut for from 5 to 12 hours. When opened the building should be well ventilated. Every precaution must be taken to prevent the vapour igniting by contact with lights or pipes, or even the sparks from electric fittings, as its igniting temperature is very low, and when mixed with air it is explosive. The vapour is poisonous, and must not be breathed, and workmen in factories where it is used are found to suffer from constantly inhaling small quantities. It should not be used for flour, but grain is uninjured by the treatment, if it is well ventilated afterwards.

As an alternative to using carbon bisulphide to destroy the insects the plan of heating might be employed. It has been found by Mr. F. V. Theobald, in the case of other grain, that any dry temperature over 140° F. killed all larvæ and pupæ as soon as the corn was well warmed through; the most successful experiments were at any temperature between 130° to 140° F., when not only larvæ and pupæ but also eggs and adults were killed, and it seems probable that on the large scale heating to a temperature approaching 150° F. for one hour would be successful. The designing of an apparatus to effect the destruction of weevils by heat without at the same time injuring the commercial value of the maize deserves the attention of manufacturers of milling machinery. The treatment should be given at the warehouse before shipping, and as soon as possible after the maize is received; the maize should then be stored away from danger of fresh infection until shipped. Messrs. Thomas Robinson & Son, Limited, of Rochdale, England, make a maize-drying machine which might, perhaps, prove effective for this purpose; it is capable of dealing with 150 bushels at a time. In this apparatus air heated by steam coils is blown by a fan through the maize placed in specially constructed chambers.

Before shipping the holds should be thoroughly cleaned and freed from insects. It has been noticed by Mr. F. V. Theobald

that grain shipped in gunny bags suffers more from weevils than that sent in bulk, the reason being that the weevils will not work deep in a mass of corn.

As regards the native practices it may be mentioned that in West Africa the cobs are sometimes kept hanging up, but when this is done they become attacked by weevils; another plan is to harvest the maize by breaking down the plants and leaving them lying for three days to dry, the cobs are then cut off and stored in thatched bins supported on wooden piles about 6 feet off the ground ; these bins allow the air to circulate through them. In Northern Nigeria the natives are in the habit of drying their millet and guinea corn in mud ovens, and then storing it in cylindrical mud towers ; this heating would no doubt tend to kill weevils if it was applied to the maize intended for sale.

Grading.—In order to facilitate the buying and selling of grain a system of grading has been adopted in the United States. In this system the grain is examined by trained inspectors and reported to be of one or other of certain divisions of quality ; by this means the buyer has an opportunity of knowing what he is buying, and the disputes are avoided which are liable to occur when the buyer purchases on the basis of a sample and considers that the grain delivered does not come up to the sample in quality. If the grading is well done the buyer is assured of the quality of the grain he will receive, and this is a matter of greatest importance ; in fact it has been stated that it is not of much consequence to dealers whether good, bad, or indifferent grain is sent so long as it is true to the sample, and the broker can safely say that the sample represents so many bushels.

The inspection departments are managed either by trade organisations or are under State control, and the charge made for grading is only a small fraction of the value of the grain, varying from about 25 cents to 75 cents per car-load or per 1000 bushels.

In the case of maize in the United States the rules recommended by the Chief Grain Inspectors' National Association classify the grain into three classes, namely—Yellow Corn, White Corn, and Mixed Corn (corn or Indian corn being the names by which

maize is always known in the United States); and in each class the grain is assigned to one or other of five grades.

The following are the rules:—

No. 1 *Yellow Corn* shall be pure yellow corn, sound, plump, dry, sweet, and clean.

No. 2 *Yellow Corn* shall be 95 per cent. yellow corn, dry, sweet, and reasonably clean, but not sufficiently sound or plump for No. 1 Yellow.

No. 3 *Yellow Corn* shall be 95 per cent. yellow corn, reasonably dry, reasonably clean, but not sufficiently sound and dry for No. 2 Yellow.

No. 4 *Yellow Corn* shall be 95 per cent. yellow corn, not fit for a higher grade in consequence of being of poor quality, damp, musty, or dirty.

No Grade Yellow Corn. (See general rule.)

No. 1 *Mixed Corn* shall be mixed corn, sound, plump, dry, sweet, and clean.

No. 2 *Mixed Corn* shall be mixed corn, dry, sweet, and reasonably clean, but not sufficiently sound and plump for No. 1 Mixed.

No. 3 *Mixed Corn* shall be mixed corn, reasonably dry, reasonably clean, but not sufficiently sound and dry for No. 2 Mixed.

No. 4 *Mixed Corn* shall be mixed corn, not fit for a higher grade in consequence of being of poor quality, damp, musty, or dirty.

No Grade Mixed Corn. (See general rule.)

No. 1 *White Corn* shall be pure white corn, sound, dry, plump, sweet, and clean.

No. 2 *White Corn* shall be 98 per cent. white corn, dry, sweet, reasonably clean, but not sufficiently sound and plump for No. 1 White.

No. 3 *White Corn* shall be 98 per cent. white corn, reasonably dry, reasonably clean, but not sufficiently sound and dry for No. 2 White.

No. 4 *White Corn* shall be 98 per cent. white corn, not fit for a higher grade in consequence of being of poor quality, damp, musty or dirty.

No Grade White Corn. (See general rule.)

No Grade—General rule.—All grain of any kind and variety that is wet, hot, or in a heating condition, burned or smoky, contains weevil, or is for any reason unfit for warehousing, shall be classed and graded "No Grade."

These rules have met with some criticism on the grounds that the terms give great latitude for individual variations of opinion; "reasonably dry" and "reasonably clean," for instance, being quite indefinite, and it has been suggested that the judgment of the inspectors should be guided and checked by actual scientific determinations of the percentages of moisture, of coloured grains, of damaged grains, and of broken grains and dirt; though of course this could not be done with every consignment, but only with a certain number of selected samples with a view to keeping the standard of grading uniform.

In Natal the Government has decided to encourage the export of maize, and in August of 1907 held a meeting of persons interested in the matter in order to obtain the advice and co-operation of the farmers and merchants, and a committee was formed to consider the matter of grading. A Government inspector has been appointed, and the following set of regulations has been issued.

GRADING REGULATIONS FOR MAIZE, *adopted by the South African Governments. Season* 1908; *Natal.*

The maize is to be classified as follows:—(A) White Flat. (B) White Round. (C) Yellow Flat. (D) Yellow Round. (E) Mixed (partly white and partly yellow in same bag).

Choice White Flat (Dent).—To be flat, sound, dry and reasonably clean, and not to be deprived of its grade by reason of an occasional red or discoloured grain.

Choice White Round (Flint).—Similar to the above, except that it must be round (flint).

Fair Average Quality White Flat (Dent).—To be dry. The grains may be irregular in size as long as they are flat; and a reasonable quantity, not more than 8 per cent., may be yellow or discoloured grains.

Fair Average Quality White Round (Flint).—Similar to above, except that it must be round (flint).

Choice Yellow Flat (Dent).—Must be flat, dry, sound, well

cleaned, and is not to be deprived of its grade by reason of an occasional white or discoloured grain.

Choice Yellow Round (*Flint*).—Similar to above, except that it must be round (flint).

Fair Average Quality Yellow Flat (*Dent*).—Must be flat, sound, dry and reasonably clean, and up to 8 per cent. of white or discoloured grains should not deprive it of its grade.

Fair Average Quality Yellow Round (*Flint*).—Similar to above, except that it must be round (flint).

Choice Mixed.—To be dry, sound and reasonably clean. The maize may be round or flat. If the sample is mainly white, yellow maize up to 20 per cent. may be allowed; if the sample is mainly yellow, white maize up to 20 per cent. may be allowed.

Fair Average Quality Mixed.—Should consist of dry, round or flat maize, or a mixture of both chiefly yellow and white maize, and may contain up to 30 per cent. of blue berries.

Note.—In each of the foregoing cases "below the standards set for fair average quality" will be regarded as "below grade."

Samples of these grades are exhibited in the Natal Court of the Imperial Institute.

THE INTERNATIONAL RUBBER EXHIBITION IN LONDON.

THE question of rubber cultivation has attracted widespread attention during recent years owing to the continued increase in the demand for rubber for commercial purposes and to the threatened diminution in the supplies from certain sources. Until a few years ago the whole of the world's supply of rubber was obtained from wild plants growing in the forests of tropical America, Africa and Asia, but latterly the cultivation of rubber trees has been extensively taken up by planters in many countries and has already become one of the most important tropical industries. The amount of rubber at present obtained from cultivated trees is only small comparatively, but as the plantations which have been established throughout the tropics come to maturity the production will be very largely increased.

Ceylon and British Malaya have taken the lead in the cultivation of the Para rubber tree, and in connection with the industry in these two countries a rubber exhibition was held in Ceylon during September 1906, an account of which was given in this *Bulletin*, 1907, **5**. 45. The success which attended this exhibition suggested that a similar undertaking of wider scope, embracing all the principal rubber-producing countries, would serve a very useful purpose. The idea was widely taken up and culminated in the first International Rubber and Allied Trades' Exhibition which has just been held in London at Olympia from the 14th to the 26th September, 1908.

The Exhibition has proved very successful in bringing together a comprehensive collection of rubber from all parts of the world, thus permitting comparisons to be made between the products of different countries, and has afforded an opportunity for planters to meet manufacturers and to learn their requirements. During the Exhibition conferences were held at which papers dealing with problems relating to the cultivation and preparation of rubber and allied subjects were read and discussed. A full report of the proceedings at these conferences will be published later in *The Official Record of the Exhibition.*

The following countries were represented at the Exhibition by exhibits of raw rubber :—

Ceylon, British Malaya, Southern India, Dutch East Indies, British East Africa, Uganda, Portuguese East Africa, Gold Coast, Congo, Brazil, Colombia, Mexico, Dutch Guiana, British Guiana, Trinidad, St. Lucia and Dominica.

These specimens of rubber formed the chief feature of the Exhibition, and the following account, dealing first with the British Possessions, will indicate briefly the nature of the exhibits and the present position of rubber cultivation in the different countries.

Ceylon.

Ceylon may be regarded as the home of rubber cultivation, since it was to this Colony that the first Para rubber plants, raised from seed collected in Brazil by Mr. H. A. Wickham, were forwarded from Kew in 1876 and established at Peradeniya. Little attention was, however, given to rubber planting for many years, and in 1899 the area under rubber in Ceylon was only

1,250 acres, with a production of 70 cwt. Since that date development has been rapid, and in 1907 there were 150,000 acres devoted wholly or in part to rubber cultivation, whilst it is estimated that an additional 25,000 acres will be planted during the present year. The exports of rubber from Ceylon during the last three years, 1905–6–7, have been 75 tons, 146 tons and 248 tons respectively, and it is expected that this year the amount will reach 300 tons.

The specimens forwarded from Ceylon occupied one of the most prominent positions in the Exhibition just on the right of the main entrance and immediately opposite the exhibit from British Malaya. The stand consisted of a central pavilion, on the walls of which maps, photographs and statistics relating to rubber cultivation in Ceylon and botanical specimens of the principal rubber trees were displayed, and this was surrounded by counters on which the samples of rubber were exhibited. The exhibits, which had been supplied by the Royal Botanic Gardens and by planters in the island, included a representative collection of the different forms of rubber at present produced in Ceylon, together with many other objects of interest to those concerned in the industry.

The Royal Botanic Gardens exhibited a series of trunks of Para rubber trees, about 6 feet in height, to illustrate the different methods of tapping at present employed, and also supplied a number of living rubber and other plants which had been forwarded in Wardian cases.

The rubber specimens were grouped according to the form in which they were prepared, viz. biscuits, sheet, crêpe, etc., and made an interesting exhibit which served to show the high average quality of the rubber produced on the plantations. Mention may perhaps be made of the Para biscuits from the Wariapolla, Glanrhos, Duckwari, and Syston estates; the Ceara biscuits from the Rangbodde estate; the Para sheet from the Suduganga and Devitura estates; the Ceara sheet from Pallekelly; the thin crêpe from the Nikakotua, Ballacadua and Putupaula estates; the thick crêpe from the Nikakotua, Culloden, and P. P. K. (Kalutura) estates; the worm and block worm rubber from Keppitigalla and Kalutura; and the block rubber from the Grand Central Estate.

A noticeable feature in connection with the biscuit and sheet rubbers was the wide variation in colour between the specimens, some being pale yellowish-white whilst others were almost black. One of the best specimens of biscuits in the Exhibition had been treated by the process devised by Mr. Kelway Bamber, the Government Chemist in Ceylon, for destroying the oxydase which is present in rubber and causes the darkening in colour. This process consists simply in coagulating the latex by means of steam, or by heating the freshly coagulated rubber in water at a temperature of 180° F. for 10 to 15 minutes. By this treatment the oxydase is destroyed and a pale coloured rubber is obtained, which it is claimed will not darken on exposure. This process certainly deserves trial by planters, since uniformity in colour is very desirable in consignments of rubber.

A model of a rubber factory, designed by Mr. Bamber, was also shown, together with specimens of the various tapping tools which have been introduced.

The Rosehaugh Tea and Rubber Co., Ltd., of Ceylon, had a separate stand, adjoining the main Ceylon exhibit, which deserves mention as one of the most interesting displays in the Exhibition. Excellent specimens of biscuits, thin and thick crêpe, block and scrap rubber were shown from the Company's estates, together with Para seeds and oil, tapping tools, stumps showing methods of tapping, and photographs.

British Malaya.

Rubber cultivation has made very rapid progress in British Malaya during the last decade. In 1897 the area under rubber in the Federated Malay States was only 350 acres, but by the end of 1907 it had reached 126,235 acres. Similar progress has been made in the Straits Settlements, and in 1907 nearly 53,000 acres were devoted to rubber in Malacca, Province Wellesley, and Johore. The total area of the rubber plantations in British Malaya is therefore approximately 180,000 acres, representing twenty-seven and a half million trees. The exports of rubber from cultivated trees in the Federated Malay States and Straits Settlements was 1,017 tons in 1907, compared with 417 tons in the previous year. The production in 1907 was therefore four times greater than that of Ceylon during the same period.

The British Malaya stand at the Exhibition occupied a similar space to that of Ceylon, and had as its central feature a typical Malay house, raised from the ground on posts. Around this were placed counters for the display of the rubber specimens, screens covered with photographs relating to the rubber industry, specimens of living rubber plants, trunks of Para trees, and other objects of interest.

The specimens were grouped according to the districts in which they were produced, different sections being devoted to Perak, Selangor, Negri Sembilan and the Straits Settlements. A striking feature was that, with the exception of the specimens from the Botanic Gardens at Singapore, no biscuits of rubber were shown, the whole of the exhibits being in the form of crêpe, sheet or block. In Malaya the preparation of biscuits has been practically abandoned in favour of sheet and crêpe, which are produced by machinery with much less expenditure of labour. All the specimens of rubber exhibited were of very high quality, and it may be noted that many of them were taken from ordinary commercial consignments forwarded to this country for sale.

From Perak good specimens of Para sheet or crêpe were shown from the Kamuning, Cicely, Sungei Krudda and Jebong estates, the crêpe from the latter estate being specially noteworthy. A block of Castilloa rubber was also exhibited from the Kamuning estate.

A number of excellent specimens of rubber were on view in the Selangor section, those from the Pataling, Highlands, Bukit Rajah and Klanang estates deserving mention.

The Consolidated Malay Rubber Estates and the Linggi plantations shows very good specimens of crêpe rubber from Negri Sembilan, whilst the sheet rubber from the Sungei Choh estate in the same section was of very fine quality. The Linggi plantations also showed an excellent specimen of Para rubber seed oil, which resembles linseed oil in properties and is likely to become an important by-product on rubber estates in the immediate future.

The Straits Settlements were represented by exhibits of Para biscuits, sheet and scrap from the Botanic Gardens and from the Trafalgar estate at Singapore, and by a number of specimens

from estates in Malacca, Penang and Johore, in the latter case from H.H. the Sultan's plantations.

Several estates showed specimens of dry block rubber, the best being from the well-known Lanadron Estate, whose exhibit of ten large blocks of pale brown rubber was one of the chief features of the stand. The only sample of wet block rubber shown was supplied by the Caledonia Estate, Province Wellesley, and was of very good quality.

An interesting collection of samples of gutta-percha, prepared near Taiping, Perak, by tapping the standing trees, was also shown.

India.

Rubber cultivation has been taken up by planters in many parts of Southern India, and the provinces of Travancore and Cochin were represented at the Exhibition. In these two provinces it is stated that there are at present 17,374 acres devoted to rubber, exclusive of 1,603 acres of rubber planted amongst tea in the South Travancore district. Of the former total 7,634 acres are situated in the Mundaykayan district. The majority of the trees have been planted within the last few years, and only a small number are of sufficient size for tapping.

The exhibits included several samples of Para biscuits from estates situated at altitudes varying from 3,500 to 4,500 feet, and also pale Ceara and Castilloa biscuits. The specimens were of very good quality, and prove that satisfactory rubber can be obtained from Para trees grown at high elevations in Southern India.

Samples of other local products of interest to planters, such as tea, cardamoms, lemon-grass oil, pepper, ginger, turmeric, coconut oil, etc., were also exhibited.

British East Africa.

The indigenous rubber plants of the East Africa Protectorate are species of Landolphia vines, principally *Landolphia Kirkii*, and the tree *Mascarenhasia elastica* which occurs on the Shimba Hills and furnishes the rubber known locally as "Mgoa." In addition to these native plants, Para, Ceara and Funtumia trees have been introduced and are being experimentally grown, but

at present the rubber exported is derived almost entirely from wild plants. The exports of rubber from the Protectorate in 1906–7 amounted to 148,624 lb., valued at £19,944.

The exhibits shown at the British East Africa stand included representative samples of Landolphia rubber as collected by the natives in different districts, of Mascarenhasia rubber from the Shimba Hills prepared by the Forestry Officers, and of Ceara rubber. Specimens of the stems of Landolphia vines showing the methods of tapping employed by the natives were exhibited together with an interesting collection of photographs illustrating the progress of rubber cultivation in the Protectorate.

Uganda.

The Uganda Protectorate was not officially represented at the Exhibition, but the Mabira Forest Rubber Co. had a stand at which were shown samples of the latex and rubber of *Funtumia elastica* accompanied by botanical specimens and photographs of the trees. The rubber was in the form of crêpe and was of very good quality, although rather dark-coloured.

A sample of biscuit rubber prepared in Uganda was included amongst the specimens sent from British East Africa.

The exports of rubber from Uganda during 1906–7 amounted to 73,191 lb., valued at £9,759.

Gold Coast.

The Gold Coast was the only British West African Colony which participated in the Exhibition.

Gold Coast rubber is at present derived entirely from indigenous plants, the two principal sources being *Funtumia elastica*, the West African rubber tree, and *Landolphia owariensis*, a vine. Large numbers of *Funtumia elastica* trees have been planted by the natives under Government auspices, and plantations of Para trees, which have been found to do well in the Colony, are being established. The exports of rubber in 1907 amounted to 3,549,548 lb., of the declared value £333,120, figures which are practically identical with those of the two previous years.

The exhibits included representative samples of the rubbers which are at present exported from the Gold Coast, such as Ashanti lump, niggers, and Krepi ball. The Gold Coast lump rubbers are derived principally from *Funtumia elastica*, but are

usually of inferior quality on account of the native methods of preparation. The rubber of *Funtumia elastica* is, however, of very good quality if carefully prepared, as was shown by a number of samples in biscuit form.

The Krepi ball rubber is derived from *Landolphia owariensis* and is usually of good quality; samples of *Landolphia* rubber in biscuits were also shown.

A number of biscuits represented the results of the experimental tapping of Para trees in the Gold Coast, and indicated that rubber of very good quality will be obtainable from mature trees.

Specimens of *Ficus Vogelii* rubber, which is usually of resinous character, were included in the exhibits.

Trinidad.

Rubber cultivation has only been taken up in Trinidad during the last ten years, but has already made considerable progress, there being at present about 50 plantations of Castilloa trees in the island. The climate and soil of Trinidad appear to be very suitable for the growth of *Castilloa elastica*, and there seems little doubt that the export of rubber will show a large increase in the immediate future. The first shipments of rubber were made in the year ending March 1907 and amounted to 1,000 lb., whilst for the corresponding period to March 1908 the exports were 4,444 lb. Very satisfactory prices have been realised for the product.

The exhibits from Trinidad comprised specimens of Castilloa rubber in block, sheet, biscuits and scrap, from several estates which are now producing rubber in commercial quantities. In addition, the Botanical Department showed a considerable number of samples of Castilloa, Hevea (Para), Funtumia, Ficus and Landolphia rubbers experimentally prepared from trees growing in the Botanic Gardens, together with photographs and specimens of living plants. Samples of balata prepared in Trinidad and in Venezuela were also shown.

St. Lucia and Dominica.

In these islands rubber planting is still in the initial stages, but the results already attained show that the Castilloa tree

can be successfully grown and will yield a remunerative return.

Large areas of Crown land suitable for rubber cultivation are available in St. Lucia, and it is hoped that the industry will develop considerably. A number of living Castilloa plants and biscuits of Castilloa rubber were shown from the Botanic Station in the island.

The trees of the rubber plantations already established in Dominica are not yet of sufficient age for tapping, but an exhibit was forwarded from the Botanic Station. This included bottles of latex of the rubber-yielding plants introduced into the island, small samples of Para, Castilloa and *Ficus elastica* rubbers, and botanical specimens of the plants.

British Guiana.

The exhibits from British Guiana comprised a number of samples of balata, a gutta-percha substitute, of which the Colony exported 634,242 lb., valued at £50,106, in 1906–7. Some very fine samples of the product were shown by firms engaged in the trade.

In addition, attention was drawn to the tree *Sapium Jenmani*, which is indigenous in the Colony and appears likely to be of considerable value as a source of rubber. Botanical specimens of the tree, with a specimen of the trunk, were shown, and also samples of the rubber in lump scrap and biscuits, the latter being of excellent quality.

Brazil.

The importance of Brazil as a rubber-producing country will be evident when it is stated that out of a total production of from 65,000 to 70,000 tons of rubber in 1907 no less than 37,000 tons came from Brazil. In view of this fact it is not surprising that Brazil made a very large display at the Exhibition. The exhibit consisted of two stands, one of which was under the auspices of the Federal Government, whilst the other was organised by the Chamber of Commerce at Manaos and was devoted to the State of Amazonas alone. On these stands were displayed commercial samples of fine Para rubber prepared in the large rounded lumps characteristic of this rubber, and known technically as "biscuits."

Some of the samples weighed over 1 ton, and a single "biscuit" weighing over 4 cwt. was shown by Messrs. Mello & Co. The exhibits comprised specimens from the different districts in Brazil, the rubber being known by the names of the tributaries of the Amazon in the valleys of which it is obtained, *i.e.* Jurua, Acre, Purus, Rio Negro, Jamary, Madeira, etc. A number of samples of Caucho slab or ball obtained from species of Castilloa were also shown.

An interesting feature of the Brazilian exhibit was the representation of one of the small huts used by the natives for preparing rubber, where the method of coagulating the latex by smoking, and the formation of the large "biscuits," was illustrated.

Mexico.

It is stated that there are at the present time 100,000 acres of rubber plantations in Mexico, and the exports of rubber (including Guayule) during the year 1906–7 are given as 4,690 tons. In view of these facts the display made at the official stand of the Mexico Government was a little disappointing in quantity. The exhibits consisted principally of samples of Castilloa rubber in block, sheet, crêpe and biscuit, and many of the specimens were of very good quality. Specially noteworthy were the samples of pale block Castilloa rubber as produced commercially at the La Zacualpa plantations.

The Guayule rubber plant was well represented, and there was also a special stand devoted to this product where samples of the crude and purified rubber were shown, together with articles manufactured from them.

The Orizaba Rubber Plantation Co. had a separate stand, and made a very good display of living Castilloa stumps, latex and rubber.

Colombia.

A large block of Colombian virgin rubber derived from a species of Sapium, probably *S. verum*, Hemsley, was shown by Messrs. Neito Rocha & Cia, of Bogota. The rubber was stated to be obtained from a plantation of trees 25 years old, growing at an elevation of from 1,20c to 2,000 feet above sea-level.

Netherlands Colonies.

An excellent collective exhibit was made by the Netherlands Government to illustrate the rubber resources of the Dutch Colonies in the East and West Indies. Rubber cultivation has been largely taken up during recent years in Java and Sumatra, and at the present time it is estimated that in the Netherlands East Indies over 87,500 acres are devoted to rubber, of which 57,000 acres are situated in Java. Many of the old plantations consist of *Ficus elastica*, but latterly the Para tree has been extensively planted. Large quantities of gutta-percha are obtained from the Dutch East Indies, and plantations of these trees have also been established in Java. The exhibits from this source consisted principally of specimens of rubber derived from the indigenous *Ficus elastica* (Rambong), prepared in different forms. Smaller samples from the exotic trees which are now being cultivated, viz. Hevea, Castilloa and Ceara, were also shown. An interesting collection of gutta-percha of different grades was on view, as well as a number of gums and resins. Maps and photographs illustrating the rubber industry were included in the exhibit.

The principal product obtained from the Netherlands West Indies is balata, of which a number of good specimens were shown from Dutch Guiana. The cultivation of Hevea and Castilloa trees has been undertaken in the latter colony during the last ten years, and small specimens of the rubber obtained, together with living plants, were shown.

Other Exhibits.

The Companhia de Moçambique exhibited specimens of Landolphia, Ceara and Mascarenhasia rubber obtained from their territory in Portuguese East Africa, and a collection of Congo rubbers was shown by Messrs. Weise & Co., of Rotterdam.

The remaining sections of the Exhibition may be briefly noticed. In the loan section the Royal Botanic Gardens, Kew, showed botanical specimens of a number of interesting rubber plants, with samples of the product which they furnish.

A large number of firms exhibited rubber machinery suitable for use on plantations for the preparation of rubber in sheet,

crêpe and block, and many varieties of tapping tools were on view. Apparatus for the chemical and physical testing of rubber also formed an important group of exhibits.

In the manufacturers' section the most striking exhibit was the new mosaic rubber flooring introduced by the Indiarubber, Gutta-percha and Telegraph Works Co., Ltd., of Silvertown. This flooring, which closely resembles the ordinary mosaic pavement in appearance, and can be made in any required colour, attracted considerable notice during the Exhibition.

Exhibits of rubber substitutes, reclaimed rubber, and chemicals used in rubber manufacture were shown by a number of manufacturers.

A selection of the exhibits shown by Ceylon, Malaya, East Africa and the West Indies, have been transferred to the Public Galleries of the Imperial Institute.

COTTON-GROWING IN THE FRENCH COLONIES.

In a previous number of this *Bulletin* (1904, **2**. 122) an account was given of the efforts made by the Colonial Cotton Association during the first year of its existence to further the cultivation of cotton in the French Colonies. Since that time the work has progressed steadily, and now after five years of sustained effort definite results have been achieved. A *résumé* of these results was given by M. Meunier, Administrator to the Association, at the Annual General Meeting held in March 1908, and has been published in the *Bulletin de l'Association Cotonnière Coloniale*, 1908, 297–319.

In 1903, at the outset of the work, two hand-gins were installed at Kayes in the French Sudan. There are now in the French Colonies no less than eighty-eight gins (including both hand and power machines), eighteen baling presses, and seven motors, four of which are driven by petroleum and three by electricity. Well-equipped ginneries have been erected at Segu and Kayes in the Sudan, and at Abomey and Cotonou in Dahomey. A ginning station has also been established at Oran in Algeria.

Eighty-three tons of cotton-seed were forwarded to the Colonies for distribution in 1906, and fifty-two tons in 1907, the

smaller quantity in the latter year being due to the fact that a system of selecting seed for sowing had been instituted at the ginneries.

The results obtained so far have been generally of an encouraging nature and in some districts are regarded as eminently satisfactory. In many localities the natives have taken a great interest in the movement, and it is expected that as the railways are extended rapid progress will be made.

In the following paragraphs a short account is given of the work carried out in the various Colonies during 1907.

ALGERIA AND TUNIS.

The progress of cotton cultivation in Algeria has already been recorded in this *Bulletin* (1907, 5. 269). During 1907 much more extensive trials have been made, and generally with very favourable results. The principal centres of work were Perrégaux, Orleansville, Blida, Félix-Faure, Philippeville and Bona in Algeria, and Jerda and Tunis in Tunis. The chief varieties grown were Mississippi, Mitafifi, and Yannovitch; but several other varieties were tested on a small scale. The results have shown definitely that the three varieties named are those best adapted for cultivation. Valuable experience was gained by these experiments with reference to the methods of cultivation, and evidence was obtained that certain regions are not suitable for cotton-growing. The progress made in Algeria in 1907 was by no means inconsiderable, as is shown by the fact that about 30 tons of cotton were produced in that year as compared with 12 tons in 1906.

SENEGAL.

The experiments which have been carried on in Senegal for several years were continued in 1907, and afforded useful indications, especially with reference to the question of irrigation. During that year 5,585 lb. of cotton were exported, whereas only 3,211 lb. were exported in 1906. The 1907–8 crop was expected to amount to about 10 tons.

FRENCH SUDAN.

Cotton cultivation in the French Sudan is rendered difficult owing to the incidence of occasional drought or excessive rain.

Continued experiments, however, have shown that the unfavourable conditions are not general, but local; and that although discouraging results have been obtained in some places, excellent results have been obtained in others. It is considered that each year in the different parts of this vast Colony such a variety of results must be expected, but that, on the whole, success will predominate; this view is supported by the results obtained in 1907. The samples which are constantly being received by the Colonial Cotton Association from persons interested in their work show that a knowledge of the regions where cotton-growing is practised and a product suitable for export obtained, is yet far from complete. It has been stated that near Lake Debo there are extensive and well-cultivated cotton-fields. Considerable quantities of good cotton are also reported as being produced in the Koutiala District. The region of Kayes has been found capable of producing cotton in abundance, and a ginnery has now been established there.

The cottons grown in the Sudan and imported into France in 1907 consisted of both American and native varieties. The amount of cotton produced was 7,683 lb. in 1905, 29,212 lb. in 1906, and 82,994 lb. in 1907.

DAHOMEY.

Attempts to acclimatise American cottons in Dahomey have not yet met with much success, and attention is therefore being directed to increasing the production of the indigenous variety, which possesses special qualities and is particularly adapted to the spinning of certain kinds of yarn. Experimental plantations have been established for instructing the natives and for producing seed for sowing. These plantations have given good results, except in one case, in which the crop suffered from the drought. At the Abomey ginnery the best part of the seed is retained for sowing, whilst the remainder is sent to the oil-mill at Cotonou. The oil-cake left after the expression of the oil is being utilised as a manure.

The amount of cotton produced in Dahomey in 1907 was about 90 tons, as compared with 33 tons in 1906 and 10 tons in 1905. The natives have gained confidence on finding that their crops have been purchased regularly for several years, and

therefore have no hesitation in enlarging their plantations. The railway has been extended northwards, opening up the region of Savé, and it has been decided to establish a ginnery in this district.

MADAGASCAR.

A careful study is being made in Madagascar with the object of determining the most suitable districts for cotton-growing, the best time for sowing, and the varieties best adapted for cultivation. Four gins and three baling presses have been sent to the Colony, and have been located at the most important centres of production. Several colonists and associations are seriously devoting themselves to cotton-growing, and encouraging results have been obtained.

WEST INDIES.

Small quantities of cotton have been exported from the French West Indies and have realised good prices. The cultivation is recommended of two well-acclimatised varieties: one, a form of Sea Island cotton, and the other a coarser variety which would be useful for spinning in admixture with wool. Experiments are also being made with a variety of tree-cotton.

Experiments in French Guiana have proved that cotton can be grown with considerable success. At one time large quantities of cotton were exported from this Colony.

NEW CALEDONIA.

An Association has been formed in New Caledonia of planters desirous of devoting themselves to cotton cultivation. By this means it has been possible to co-ordinate experiments and compare experiences, and much valuable information has thus been gained. A variety of cotton grows wild in almost all parts of the Colony, and yields a fibre of a type resembling Peruvian cotton; good results are anticipated from the cultivation of this variety. Large areas are being put under cultivation in several different parts of the island. The Colonial Cotton Association has forwarded two gins to the Colony, and is assisting the planters by furnishing seed for sowing.

INDO-CHINA.

Large quantities of cotton are produced in Cambodia which find their way to the markets of the Far East. The material is utilised principally as wadding for padding garments, since it is so badly ginned as to be unsuitable for spinning. The ginneries belong to the Chinese, who secure the crops by making advances to the growers. It is hoped, however, that, by the installation of better ginning equipment, a solution will be arrived at which will permit of the cotton being attracted to the French market, the farmers thus being enabled to obtain a larger profit. With this object in view, twenty hand-gins were forwarded in 1907 to Indo-China by the Colonial Cotton Association and placed in the villages of the cotton-growing districts.

The quantities of cotton produced in the French Colonies during 1906 and 1907 are given in the following table, the figures representing the weight of ginned material.

	1906. lb.	1907. lb.
Senegal	3,211	5,585
High Senegal and Niger	29,212	82,994
Dahomey	74,330	201,545
Guadeloupe	4,082	2,297
Algeria	27,180	69,922
Total	138,015 (or about 300 bales).	362,343 (or about 750 bales).

It is expected that during the present year more than 1,000 bales of cotton will be imported into France from her Colonies.

EXPERIMENTS IN JUTE CULTIVATION IN BENGAL.

These experiments were commenced at the Burdwan Station in 1904 and the results obtained up to the end of 1907, together with those obtained at the Cuttack Station, are

published in Leaflet No. 1 (1908) of the Bengal Agricultural Department.

The results are likely to be of great use to cultivators of jute in other parts of the world, and are therefore given below in some detail. The following series of experiments has been made: (1) manuring; (2) cutting at different stages of growth; (3) varieties of jute; (4) spacing; (5) drill *versus* broadcast sowing; (6) rotation of crops.

The soil of both the Burdwan and Cuttack stations is sandy loam deficient in nitrogen, phosphoric acid and lime, that of the latter station being so poor that manures must be used to obtain a fair crop. These soils are typical of the districts.

In the cultivation of jute the usual treatment of the land consists of 8 ploughings, 3 to 6 harrowings, and for after-cultivation 2 or 3 harrowings, 1 thinning, and the necessary weeding. The dates for sowing and harvesting vary with the locality, but the seed should be sown as early as possible in order that the crop may be sufficiently strong to withstand the heavy rains, and that it may be cut while there is plenty of water for retting. After harvesting, the crop is allowed to lie in the field in bundles for one or two days and is then retted during twelve to fourteen days, washed and dried in the sun.

In the manuring experiments sufficient quantities of the various manures to furnish 30 pounds of nitrogen per acre were applied to the land just before sowing the seed; the following quantities being required:—

Cowdung . . .	560 lb.	per acre.
Castor cake . . .	600 „	„ „
Bonemeal . . .	900 „	„ „
Bonemeal and saltpetre	{ 460 „ 160 „ }	„ „

The results prove that either castor cake or cowdung gives the best yields of fibre and is economical in use; the quality of the fibre produced does not differ greatly with the particular manure employed, but manuring with cowdung appears to give a slight advantage in this respect. As an average of four years' work the yield on the plot manured with castor cake was 1,895 lb. per acre, and on the unmanured plot 1,472 lb. per acre.

In addition, the use of small quantities of soluble manures, *e.g.* ammonium sulphate, kainite, superphosphate, together with cowdung or castor cake, has been tried, and as an example the plot manured with a mixture of cowdung, 800 lb., superphosphate, 320 lb., and ammonium sulphate, 160 lb., gave a yield of 1,540 lb. of fibre per acre, whilst that manured with 800 lb. of cowdung alone gave only 1,000 lb. The effect of liming the soil is also being investigated; the plot manured with cowdung and lime gave 100 lb. per acre more fibre than the unlimed plot.

The experiments on the effect of cutting the stems at different stages are of great interest, in view of the uncertainty which exists about this important question. The following table shows the results obtained :—

Stages when cut.	Average for three years.	
	Yield of fibre per acre.	Value of fibre per acre.
	lb.	£ *s.* *d.*
1. Before flowering	1,210	16 19 0
2. In flower bud	1,630	18 19 0
3. In flower	1,827	19 7 0
4. When fruits are formed	1,923	19 5 0
5. When fruits are ripe	1,987	—*

* *The value for one of the three years is not available, therefore no average can be given, but the value of the fibre from stage five is very slightly less than that from stage four.*

It is clear, therefore, that the longer the plant grows the higher is the yield of fibre, and although it is usually said that the fibre grows coarser and less valuable with the age of the plant there is very little to choose in the value of fibre from the last four stages. Probably the fourth stage of growth is the best, when the fruits are forming, as there should then be sufficient water available for retting.

Of the two species of jute, *Corchorus capsularis* and *Corchorus olitorius*, 57 so-called varieties were originally planted in 1904. Many of these have been found to be apparently identical, and only the 10 best varieties of 1906 are now being planted. These varieties yield from 1,120 lb. to 2,480 lb. of fibre per acre (the lower figure probably being due to a bad season). The Bengal Provincial Agricultural Association has opened two

seed farms, and has now a stock of good seed of the best varieties, which can be obtained on application to the Agricultural Department.

A further matter which is being investigated is the selection of early and late races in order to overcome the difficulties caused by having too large quantities of stems ready for retting at one time. The values of the fibre obtained from "early" and "late" varieties of jute grown at the Burdwan experiment station did not differ greatly.

It is well known that certain "marks" of jute always fetch higher prices, owing to superior fineness and silkiness, but whether this is due to the environment, to some intrinsic quality of the particular variety of plant, or to slight modifications in the methods of preparation, are questions still under investigation.

In order to determine the effects of different spacing, plots were sown and the plants ultimately thinned out to 4, 6, 8, or 10 inches apart; as was to be expected, the 4-inch plot gave the best yield. Very little difference was noted in the quality of the fibre obtained in the four cases.

Neither the yield nor the quality of the fibre differ appreciably when the seed is sown by (1) drilling, or (2) broadcasting, and it is therefore evident that there is no necessity for small cultivators to buy drills.

Experiments are still in progress with paddy and potatoes as rotation crops with jute.

GERANIUM OIL.

THE name "geranium oil" has been applied in commerce to two classes of oils: (1) the andropogon oils, *e.g.* palmarosa oil (Indian geranium oil), and (2) the pelargonium oils, *e.g.* oil of rose geranium, although it is becoming the usual practice to restrict the name to the latter oil. In the present article it is only proposed to deal with the true rose geranium oil obtained from various species of *Pelargonium*, of which the "scented geranium" commonly grown as an indoor plant in this country is a type.

These plants, which are indigenous to South Africa, were first introduced into Europe in 1690 and have long been cultivated in France for the production of oil. The cultivation extended thence to Algeria, and at the present time the latter country is the chief source of the oil, the exports for the last three years being as follows:—

	cwts.
1905	1,035
1906	1,075
1907	761

Pelargoniums have been cultivated in Spain, near Valencia, and in the province of Almeria, and also on a smaller scale in Austria and Central Germany.

The Island of Reunion has also become an important centre of this industry and now holds second position with regard to the production of the oil, the exports for the last two years being:—

	cwts.		cwts.
1906	623	1907	615

Of the commercial varieties the Spanish oil brings the highest prices, the French and African (Algerian) coming next in quality, whilst the Reunion oil is of somewhat lower value.

Cultivation.

Three species of pelargonium are commonly cultivated for distillation: (1) *Pelargonium odoratissimum* (Willd.); (2) *Pelargonium capitatum* (Ait); (3) *Pelargonium roseum* (Willd.).

In Reunion the cultivation is largely carried on at altitudes of 1,300 to 1,400 feet, on waste land on which neither sugar-cane nor vanilla can be produced. At greater elevations than this the winter cold is too severe and the plants are destroyed by frost. The soil found at this altitude is rich in humus and is eminently suitable for the cultivation of the plant. The leaves of the plant after the extraction of the oil (1 lb. of which is obtained from 600 to 700 lb. of leaves on distillation) are employed as manure.

Much valuable information on the subject of pelargonium cultivation is given in an account of experiments carried on in Italy published recently in *Coltivatore* (1906).

These experiments were conducted by Dr. E. Blandini at the Agricultural School at Portici, and seem to have been made principally with *Pelargonium roseum.* This plant has been shown to require a deep rich soil, which will be cool in summer and fairly dry in winter. The soil ought to contain a small proportion of lime, and the plantation requires to be well tilled and manured. The importance of proper manuring may be illustrated from the fact elicited in these experiments that *Pelargonium roseum* cultivated with stable manure alone yielded 59 cwts. of flowers (containing 1·98 per cent. of oil) per hectare ($2\frac{1}{2}$ acres), whilst with a mixture composed of stable manure and superphosphate the yield was 78·7 cwts. of flowers (containing 3·17 per cent. of oil) per hectare. The stable manure was employed in the proportion of 3 cwts. and the superphosphate in lots of 8 cwts. per hectare ($2\frac{1}{2}$ acres). These two manures were mixed with the soil in the first year of planting, and the yields given above are those of the second year of cultivation.

When the ground has been put into proper condition by thorough tillage, and has received the necessary manure, the planting of two-year-old plants, raised from cuttings in special nurseries, may be proceeded with. The mother plant from which the cuttings are taken should be four years old, and in taking cuttings it is important to take some of the old wood, but the cutting should be topped and stripped of its leaves. In hot climates planting should take place from October to the first days of February; in colder climates from August to September. The cuttings should be placed about 12 to 16 inches apart and arranged in lines. Another method, equally recommended, consists in spacing the cuttings 20 inches apart in all directions. A month or so after planting the cuttings will have taken root.

The plantations should be weeded, and, when circumstances permit, irrigated. During rigorous winters it is well to shelter the young plants. The plants continue to give a good yield of oil for a period of from four to eight years.

It has been maintained that the green branches and the leaves alone contain oil, but the researches of Dr. Blandini have established that the flowers, at any rate of *P. roseum*, also contain it in notable proportions and yield oil of fine quality.

When the green branches and the leaves are alone used for

distillation only two or three crops a year are obtained. The gathering takes place in May, August and September; the yield is usually 315 cwts. of branches and leaves per hectare (2½ acres) at the first gathering; 63 cwts. at the second, and 120 to 160 cwts. at the third. In the first year only one gathering is taken, and this in August or September. When the flowers also are used the gathering of these is not made at a fixed date, but periodically, depending on the quantity of flowers available. In the experiments made at Portici, Dr. Blandini gathered eight lots of flowers between the 18th April and the 14th June. Two and a half acres yielded 77 cwts. of flowers, which on distillation gave 15½ lb. of oil.

Whether green branches and leaves or flowers are being collected, the reaping should be done in sunny, cloudless weather.

The results obtained in the Italian experiments already referred to showed that the yield of oil from twigs and leaves was about 0·1 per cent., the leaves alone furnishing from 0·70 to 0·80 per cent. The yield of oil from flowers alone from a two-year-old plantation was about 1·5 per cent. The plants are said to give the best yield of oil in the spring-time.

Referring to the cultivation of geranium, Gildemeister and Hoffmann (*Volatile Oils*, p. 449) state that it is reported that plants grown on dry soil give a smaller yield but a finer oil than those grown on irrigated soil. The average yield of the oil is said by these authorities to vary from 0·15 to 0·33 per cent. In an investigation on the effect of weather conditions on the constituents of the oil of *P. odoratissimum*, Jeancard and Satie (*Bull. Soc. Chim.*, 1904, **43**. 317) found that cold nights caused a decrease in the amount of oil present in the leaves.

As the result of cultivation experiments conducted in France, Grec, in the *Reveil Agricole* (May 26, 1901), stated that a hectare (2½ acres) produces 39·3 tons of fresh plants, and that the land is only required for five or six months. M. Grec states that, like all rapidly growing plants, pelargonium requires a large supply of water and a good deal of manure, especially of kinds which quickly decompose. It should be mentioned that in France the pelargonium (probably *P. odoratissimum*) is usually grown as an annual plant, hence the reference above to

its only occupying the soil for six months. As already stated, it has long been believed that the flowers are odourless, and it has been the general practice to harvest the plants before they blossom, when the leaves are beginning to get yellow and the lemon odour has given place to the more rose-like odour.

Charabot and Laloue state (*Comptes Rendus*, 1903, **136**. 1467) that the stems of *Pelargonium odoratissimum* do not contain a trace of essential oil, that the seat of the terpene compounds is exclusively in the leaves, and that this explains why the flowers are odourless. By the distillation of 174 lb. of leaves they obtained 5½ oz. of oil.

In considering these contradictory statements regarding the occurrence of oil in the flowers, it should be borne in mind that Blandini's experiments were confined to *Pelargonium roseum*, whilst those of Charabot and Laloue were conducted on *Pelargonium odoratissimum*. It is possible that in these two species the distribution of terpene compounds may differ.

In Reunion the plant chiefly cultivated is probably *Pelargonium capitatum*.

For the production of the oil in Reunion the distillers use stills of simple construction of which some 250 are in operation in the whole colony. A tax of 10 francs per still is levied annually by the Reunion Government.

Constituents of Geranium Oil.

The principal constituents are the alcohols geraniol and citronellol, the former of which is present to some extent in the form of its tiglic acid ester. The constituents of the Reunion oil are as follows:—

Alcohols.—Geraniol, citronellol, linalool, amyl alcohol.
Hydrocarbons.—Pinene, phellandrene.
Ketone.—Menthone.
Acids.—Tiglic acid and a small quantity of mixed fatty acids.

The proportions of these constituents vary somewhat in the different oils of commerce and consequently the physical properties are also subject to slight variation, as the following table—taken from Messrs. Schimmel & Co.'s Reports—shows:—

Source of oil.	Yield from raw material.	Specific gravity at 15° C.	Optical rotation.	Amount of ester calculated as geranyl tiglate.
	Per cent.			*Per cent.*
Algerian herb	—	0·892 to 0·90	– 6° 30′ to – 10°	19 to 29
German ,, (*P. roseum*).	0·18	0·906	– 16°	—
French ,, ...	—	0·897 to 0·905	–7°30′ to –9°30′	25 to 28
Reunion ,, ...	—	0·889 to 0·893	– 8° to – 11°	27 to 33
Spanish ,, ...	—	0·897	– 10° to – 11°	35 to 42

The commercial oil is sometimes found to be adulterated, and the ease or difficulty of detecting the added impurity depends on the nature of the adulterants used. A pure normal oil should give a clear solution with three volumes of 70 per cent. alcohol. This solubility test, and the determination of the specific gravity, optical rotation and ester content are generally sufficient to enable sophistication to be detected.

Umney and Bennett have examined recently a sample of geranium oil produced in Sicily (*Pharm. Journal*, 1905, **75.** 860). The oil, which was obtained in very small amount (0·07 per cent.) from plants grown on dry soil, was stated to have a pleasant odour. The physical constants resembled those of the Spanish geranium oil, and the ester content was 35·6 per cent. (calculated as geranyl tiglate). Unlike the French and Algerian oils, it was insoluble in 70 per cent. alcohol, but gave a clear solution with two volumes of 80 per cent. alcohol.

In Cyprus the cultivation of *Pelargonium odoratissimum* is being carried on experimentally, and a small specimen of the oil produced, which appears to be of fine quality, has been received recently in the Scientific and Technical Department of the Imperial Institute.

UTILISATION OF SEAL SKINS AND THE SKINS OF OTHER AQUATIC ANIMALS.

As inquiries relating to the demand for the skins of aquatic animals to be used in the manufacture of leather have been received in considerable numbers at the Imperial Institute of late, it has been considered desirable to summarise the information available on the subject for publication in this *Bulletin.*

Leather is made in greater or less quantity from the skins of practically all the aquatic mammals, and the skins of a few species of fish are also utilised in this way, but owing to the rather uncertain nature of the supply, the leathers are utilised generally for the production of novelties or fancy goods. Some of these leathers are, nevertheless, of considerable economic importance, notably those made from the skins of the porpoise, alligator and walrus.

Preparation of the Skins.

It is always necessary in preparing skins for tanning to exercise great care in removing them from the animals. Knife-cuts greatly depreciate the value of the skin, and the same applies to hides which have been injured through the animals fighting. Such skins should be rejected, or at least packed and dealt with separately from the uninjured ones.

After removal of the skin, the fins and tail-pieces are cut off, and as much as possible of the blubber and any adhering flesh removed. The skins are next "salted" to prevent decomposition, and as they are generally very oily in character, this is best accomplished by "dry salting" or plentifully sprinkling with salt. Borax has also been suggested for this purpose, and although more expensive, could probably be used in smaller quantity than salt. In many countries supplies of sodium sulphate are obtainable cheaply, and there is reason to believe that sodium sulphate in the anhydrous form would be as efficient an antiseptic as common salt; borax and sodium sulphate have also the advantage of being more easily washed out—a process necessary as a preliminary to tanning—than salt. In the dry, salted condition skins may be kept for a considerable time and readily transported over long distances without deterioration. After being received at the tanneries most of the oil is removed by pressure, and the hides are at once placed in the lime-pits in order to loosen the hair. In some cases fish skins are not limed, as this material destroys the fibre, but it is usually found desirable to lime fish skins in order to remove the scales. If the skins are fresh, moderate liming does not seem to affect them.

The other steps in the tanning process, viz. fleshing, depilation, drenching and bating, are carried out in the usual way,

and the skins may be tanned with vegetable or mineral tanning agents.

VARIETIES USED.

Hair Seal Skin.—The so-called "hair seals," which are quite distinct from the "fur seals," are all members of the family *Phocidæ*, and are found generally in Northern waters, particularly off the coasts of Labrador and Newfoundland, in the waters of Greenland, and along the Nova Scotia and New England coasts. The Newfoundland fishery is by far the most extensive, and gives employment to thousands of men, chiefly from Scotland and Newfoundland.

The majority of the Newfoundland seals are Greenland seals or harp seals (*Phoca groenlandica*), but a large number of hooded or bladder-nosed seals (*Cystophora cristata*) are also obtained. The same applies to the principal seal fishery of Northern Europe, which is carried on in the Polar seas by vessels sailing chiefly from Dundee.

In the seas north of Russia, especially in the White Sea and in the vicinity of Nova Zembla, many harp seals are taken in the spring by the natives of the coast, and by vessels from Norway. This fishery is not very extensive, and the total catch is usually about one-fifth that of Newfoundland.

"Harp seals" are so called because of a harp or saddle-like mark which occurs on the back of the adult male. Harp seal skins are known in commerce under a variety of trade names, of which the following appear to be the most common :—

The "whitecoat" is the skin of the very young seal, which is covered with a white fur. The skin of the older animal, covered with short hard hair, is termed a "hair." The name "saddler" is applied to the skin of the adult male, and is so called from the black saddle-like marking on the back. The young hood seal skin is known in trade as a "blue back," and is chiefly used for the fur, as it is not so suitable for leather. The skin of the adult hood seal is known as a "large spot," and is used for leather, although it is not as good for this purpose as the harp seal skin. The term "cat" is applied to very small skins of any kind of seal, implying that they are no larger than cat skins.

At one time considerable quantities of hair seal skins were

shipped from the Falkland Islands, and samples of the skins sent to the Imperial Institute were valued in 1905 at about *7s.* each. It is estimated by the local authorities that at present about 5,000 hair seals could be taken off the Islands each year without unduly depleting the rookeries. A sample of tanned and dyed seal skin is shown in the Falkland Islands Court of the Imperial Institute.

The world's supply of hair seal skins is estimated at about 850,000 annually, and valued at about £120,000. London appears to be the chief market for these skins, and most of them are tanned in Great Britain, particularly in London, Newcastle-on-Tyne and Dundee.

The method of tanning is practically that described above. When carefully prepared, seal leather is said to have greater strength and durability for its weight than any other on the market. It has also an attractive grain, and is consequently in demand for bookbinding and the production of card-cases, pocket-books, etc. A very large proportion of it is "enamelled" for belts and boot-uppers, and a considerable quantity of black grained (morocco finish) seal-skin leather is also used for the same purpose, although it is not now so fashionable as previously, owing, it is said, to the difficulty of distinguishing it from the cheap printed imitations.

Sea Lion Skin.—The skin of the sea lion (*Eumetopias stelleri*) was formerly considered unfit for tanning purposes, but at the present time the hide is probably as valuable as the oil. From the skins of the young animals a soft velvety leather is obtained, and the thicker skins obtained from the old animals when tanned are employed as a substitute for walrus hide leather in preparing the polishing wheels used by metal-workers.

Sea lion skins are tanned in the same way as seal skins, the only difference in treatment being the longer time taken, due to their greater size and thickness. Much of the sea lion leather on the market is said to have been made from seal skin.

Walrus Hide.—The trade in walrus leather is considerable, and it is estimated that about 100,000 lb. of the hide is used annually. It is a thick, heavy leather, and is principally used in making wheels for use by silversmiths and other metal-workers, for polishing fine metal surfaces. The hide is particularly suitable

for this purpose owing to its peculiarly tough grain, and to the fact that the open character of its fibre enables it to hold the polishing powder. It is usually cut into solid leather wheels, or a ring of the leather may be fastened to a wooden core suitable for attachment to a revolving head or mandril. Nearly the whole of the walrus leather used for this purpose is tanned in Great Britain, and the average value of a tanned hide suitable for polishing purposes exceeds £20. Another use to which tanned walrus hide is put is as a covering for the rollers used in ginning long and medium staple cotton, such as the Sea Island, Egyptian and Improved Upland cottons. This is stated to be a comparatively recent application, but the leather appears to be well adapted for the purpose, and more satisfactory than bull-neck leather and similar materials previously employed. When walrus leather is used, strips of it are attached to a wooden spindle ; solid leather rollers being only employed with cheaper hides.

For the thin, pliable, fancy leathers obtained from the skins of young animals tanning is conducted in the ordinary manner, but in tanning the thick hides intended for polishing purposes the tannage is made as thick and heavy as possible, and when properly conducted the operation occupies about a year.

It is stated that much of the fancy "walrus leather" on the market is made from seal skin, which is given an imitation walrus grain in the process of currying.

Manatee and Dugong Skin.—The manatee (*Manatus americanus*) is found in the shallow waters of tropical seas, and occurs principally among the West Indian islands and off the coasts of Brazil and Florida and the Senegambian coast of Africa. Having been extensively slaughtered for its valuable oil, it is now comparatively scarce.

The dugong (*Halicore dugong*) is the manatee of the Asiatic and Australian coasts. It differs slightly in appearance from the Atlantic animal, its tail being fluked instead of spoon-shaped.

The skin of the manatee and of the dugong is hard and thick, and shows comparatively few hairs. When salted it is of a dark lead colour. Manatee and dugong leathers are characteristically grained, and very difficult to imitate. For this reason, and as

there is only a small supply of the real skins, there is very little of this type of leather on the market. It is used almost wholly for small articles, such as card-cases, belts, etc.

Porpoise Hide.—The porpoise leather of commerce in the United Kingdom is made from the skin of the beluga or white whale (*Delphinapterus leucas*). This species attains an average length of 14 feet, and a circumference of about 10–12 feet, and is found chiefly along the coasts of Northern Europe, and to a less extent in the Gulf of St. Lawrence, and off the coast of Newfoundland, etc. The fishery is carried on principally by vessels from Dundee, and from ports of Norway and Sweden. It is estimated that about 6,000 white whales are taken annually, most of these being from Northern Europe. Of equal importance is the Hatteras porpoise or bottle-nosed dolphin, which occurs in great abundance off North Carolina and New Jersey.

In preparing porpoise hides the flippers and the dorsal fin are removed, and the skin and blubber cut along the middle of the back and abdomen from the nose to the flukes, the whole being peeled off in two parts. The blubber is shaved off and kept for oil extraction, whilst the hides are salted for transport.

Most of the beluga skins are tanned in Dundee or Glasgow. Porpoise tanning in the United States is carried on principally at Newark, New Jersey.

Porpoise (or beluga) leather possesses great tensile strength, and for this reason is particularly suited to the manufacture of machinery belts. It is also largely used for leather shoe-laces on account of its strength and durability.

Alligator and Crocodile Skins.—A considerable demand has arisen in recent years for alligator and crocodile leathers to be used for the manufacture of fancy articles, such as bags, slippers, belts, card-cases, etc.

Nearly all the leather of this class is prepared from the skin of the American alligator, although there appears to be no reason why the skins of other saurians, and particularly that of the crocodile, should not be employed to a greater extent than at present.

The skins of this type most sought after are those of the alligator of Florida, Louisiana and Mexico. Each of these shows peculiar characteristics, but resembles the others as a

whole. The skins of the caymans from Brazil and other South American countries have a much heavier and more horny exterior than the above, and the same applies to the skins of the crocodile of Egypt and elsewhere.

The skin is removed by cutting through the scaly covering, longitudinally from the nose to the tail, along either side of the ridge on the back, or in the middle of the under-surface. A cut is then made running from the longitudinal incision to the middle of each of the legs, either above or below according to the position of the primary cut. After cutting round the jaws the skin is removed in one piece. Great care is taken to avoid careless cutting of the membrane, as such cuts show up very distinctly when the skin is tanned and stretched. The skins are then salted, and packed in barrels ready for shipment.

Most of the crocodile leather is prepared in the United States, but a considerable amount is now tanned in this country. The process of tanning is similar to that adopted for ordinary hides, but owing to the scaly character of the skin special precautions have to be taken to obtain complete and uniform formation of leather. Skins of sizes from 3 to 5 feet are employed, and there is no market for skins from monster alligators 10 to 15 feet in length.

The demand for crocodile leather has been met to a large extent by imitations manufactured by stamping other leathers. These imitations possess the characteristic markings of the real skins, and are not readily distinguishable from them, and their successful manufacture is stated to have seriously diminished the market for alligator skins.

Whale Skin.—It has been reported recently that attempts have been made, especially in Newfoundland, to popularise leather made from the skin of the whale. The leather is said to be very tough, and to be particularly adapted for upholsterers' work. It is also claimed that it can be used for boots and shoes.

Leather made from the intestines of the whale is said to resemble kid, and to be very thin and tough, to take dyes readily, and is suggested as a suitable material for glove manufacture.

Skins of Sharks, Dog-fish, etc.—The skins of sharks, rays and

dog-fish, although rough and studded with horny protuberances, are, when tanned, very durable and resistant to water absorption. The demand for this class of skins is very limited, and their preparation is practically confined to France and Turkey, and to a less extent China and Japan. In tanning shark skins for leather or ornamental purposes an alum process ("tawing") is generally adopted.

Mention must be made of the various forms of shagreen which are made from shark skin. A common form which was formerly much used for sword-belts and the handles of other instruments and covering-cases of various sorts, was prepared from the skin of the dog-fish (*Scyllia* and *Chiloscyllia*, etc.), which is covered with small, pointed, closely-set, calcified papillæ. This particular kind of shagreen is also extensively employed by cabinet-makers and others for smoothing or polishing woods. The beautiful green shagreens which were formerly much in vogue were probably made from the skins of a larger species of shark. The skin was dyed, and the protuberances were then ground down to a level surface, thus producing a beautiful shading of colour. There seems no doubt that such shagreen would be readily saleable at the present day if it could be produced at a reasonable price.

Sturgeon Skins.—Although thick and unwieldy, sturgeon skins are sought after to some extent for producing ornamental leathers, owing to the rows of horny bosses with which they are covered, and which render them attractive. This is particularly the case with some of the species found on the European coasts, the bosses varying in form from mere dots to irregular protuberances nearly half-an-inch in length.

The methods in use for tanning these skins vary greatly, depending on the type. Some varieties may be limed, whilst others disintegrate completely in a lime bath. Alum tanning is generally employed, either alone or in conjunction with vegetable tanning agents. The tanned skins are generally dried without any special dressing.

Water Snake Skins.—The texture of the skin of the water snake is similar to that of the alligator, being close and compact. Its thinness renders it unsuitable for many purposes, but its curious markings make it attractive for the manufacture of

small articles. Most of the water snake skins on the market are tanned in France.

Miscellaneous.—In addition to the foregoing, successful experiments have been made in the preparation of leather from the skins of cod, salmon, and other fish. In Egypt, fish skins from the Red Sea are made into sole leather, and burbit skins have been tanned in Russia and Siberia for similar purposes. Fish skins, and to a less degree the skins of all aquatic animals, are much more sensitive to heat than those of terrestrial animals, and tanning processes which are safely conducted at 30–50° C. with ordinary skins must be done in the cold with fish skins. The skins of frogs and toads are used to a limited extent for leather manufacture, but this industry is practically confined to France, where a few factories pay special attention to their preparation, the raw skins being obtained from Northern Africa, Brazil, and other tropical regions.

In the compilation of the foregoing article assistance on various points has been kindly afforded by Prof. Procter, of Leeds University, and by the Authorities of the Natural History Section of the British Museum.

PEARL FISHERY OF LAKE TAMPALAKAMAM, CEYLON.

A FISHERY for an inferior kind of pearl has long been carried on in Lake Tampalakamam, a shallow, land-locked bay of great extent, situated on the west side of Great Bay, Trincomalee, on the north-east coast of Ceylon. So ruthlessly was the fishery prosecuted for a number of years that the beds at last became non-productive, and since 1890 no fishery has taken place.

In the year 1857, Dr. Kelaart furnished a preliminary report on the fishery, and since that time no further steps seem to have been taken in the matter, until May 1905, when Mr. James Hornell, F.L.S., marine biologist to the Ceylon Government, was commissioned to make a biological survey of the lake. An account of the fishery as supplied by Mr. Hornell is contained in the *Ceylon Marine Biological Reports*, 1906, **1.** Part 2, 41, from which the following summary has been prepared.

The main axis of Lake Tampalakamam (usually corrupted into Tamblegam Lake) lies in a north-east and south-west direction, and measures four and a half nautical miles; the breadth varies from one to two miles, the general outline being that of a parallelogram.

The bottom of the lake is remarkably level, maintaining a depth of from six to nine feet over the whole of the area save for a few well-marked banks or "kallums," which here and there rise close to the surface. The bottom of the lake consists of a dark greyish black mud, known as "*mei seru*" or ink mud, intermixed in places with more or less quartzose sand.

Owing to the shallowness of the lake, the water varies several degrees in temperature between morning and evening and mid-day; the general average for noon, for the whole year, being approximately 88° F.

The species which furnishes the fishery is *Placuna placenta*, L., a peculiar Lamellibranch mollusc, provided with white translucent shells, discous in outline and excessively compressed laterally. It possesses no relationship with *Margaritifera vulgaris*, Sch., the Gulf of Manaar pearl oyster (see this *Bulletin*, 1905, **3**. 125; 1908, **6**. 78), but is closely akin to *Anomia ephippium*, the horse-shoe oyster of British waters. From the latter it differs in wanting, in adult life, a "byssus" or organ of attachment. It lives free, and prefers the muddy flats of such shallow tidal bays as Lake Tampalakamam, where it lies with the hinge and about a third of the dorsal surface buried in mud.

During the first year of its existence the valves are perfectly transparent, so that the general anatomy of the oyster can be clearly seen, even to the beating of the heart. Ray bands of the palest pink, diverging from the hinge to the free edge of the shell, are sometimes exhibited by young specimens up to the time they reach two inches in diameter, but the majority show no colour and are clear and transparent. At two years of age the shells become more massive, and gradually turn white and translucent.

Mr. A. Willey states in *Spolia Zeylanica* (August 1908), that the largest oysters examined last October were immature, whence he concludes that Placuna does not produce an annual brood, but that an interval of a year or more occurs between each

generation, and that superficial growth of the shell is completed before sexual maturity is attained.

About three years appears to be the average life-span of *Placuna placenta*, during which period it attains a size of about seven inches by six inches. Specimen shells of full-grown oysters are shown in the Ceylon Court of the Imperial Institute. Apart from their use as a substitute for window-glass the shells do not appear to be at present of any other value, although it has been suggested that a good lime might be made by burning them.

The reason for the fishery is the presence, in great abundance, of an inferior kind of pearl in full-grown window oysters. According to Dr. Kelaart these pearls are about two-thirds less in value than those of *Margaritifera vulgaris*, but the quantity yielded by the window oyster is at least treble that obtained from the other species.

The pearls are small and wanting in symmetry and lustre, but occasionally they are found sufficiently large and well-shaped to be utilised in the manufacture of jewellery. At best their substance is much softer than that of the Margaritifera pearls; a steel point will scratch a pearl of Margaritifera with difficulty, but with the same instrument a scratch on a Placuna pearl is easily effected.

The majority of Placuna pearls are sent to India, where they are used in certain funeral rites for placing in the mouths of the dead, and also when calcined as a luxurious form of "chunam" for chewing with betel. In China they enter largely into medicine, either in powder or solution.

Prior to Mr. Hornell's inspection no investigation or suggestion had been made as to the causation of pearls in *Placuna placenta*. As a result of his researches Mr. Hornell has been able to prove the nucleus of the pearl to be the dead remains of a Platyhelminthian larva of the same stage and species as that which forms the cyst pearls in *Margaritifera vulgaris*. In details of form and structure the larvæ infecting Placuna appear identical with the Margaritifera parasite, but are much smaller in size and occur in groups of as many as fifty individual cysts, instead of singly or in clusters of three or four.

An observation of much importance was the discovery of parthenogenesis taking place within the bladder-like posterior

portion of the body of the parasite. Only one secondary larva is produced at a time, and this is identical with the parent form. It is probable that these young individuals escape through the body-wall of their parents and form separate cysts, and in this way the large number present in a group can be accounted for. The parthenogenetic reproduction of this particular pearl-producing parasite probably also accounts for the small clusters of three or four true cysts pearls which are occasionally found in Margaritifera, since it no doubt occurs in that species as well, although it has yet to be observed.

During the past century the Government has drawn a small revenue from the rental of the fishing rights of Lake Tampalakamam. For the eighteen years prior to 1857 this rental averaged £344, a small sum compared with previous records; but this has gradually fallen, so that for the last fishery, 1888–1890, a sum of only £200 was paid. The fishery has been invariably let to native speculators for periods of three consecutive years. The divers receive half the catch as their remuneration, but they are bound by custom to open their oysters fresh, and to sell what pearls they may contain for virtually what the renter cares to give them. Each diver makes from three hundred to five hundred descents in a day, and if the oysters are fairly plentiful may fish from 2,000 to 3,000 per day. It is estimated that during some of the previous fisheries as many as eighteen millions of oysters have been taken in the three years. In the past a total disregard has been shown of the necessity of providing adequate breeding reserves and protection to the immature oysters, and this is the sole cause of the suspension of the fishery. Hitherto there has been no restriction as to the number of oysters removed or the size at which they should be fished, and it is only the wonderful powers of reproduction possessed by the oyster that has delayed the exhaustion of the beds so long.

It has taken the beds from 1890 to the present to make a partial recovery, and they are still so restricted in extent that fishery greed, if uncontrolled, may easily bring about another long series of blank years; on the contrary, under proper management the fishery should become the source of a fairly regular annual revenue to the Government of from Rs. 10,000 to Rs. 12,000, or possibly even more.

The following is a synopsis of Mr. Hornell's recommendations: (1) The enactment of an ordinance vesting the monopoly of the fishery for window oysters in the Government, and giving the authorities power to make by-laws for the protection of the beds and the proper conduct of the fishery. (2) The abolition of the old system of renting out the fishery for periods of three years, and the substitution of a fishery on Government account, with periodical auction sales of the oysters at a rate per thousand. (3) The divers' share of the daily catch to be reduced to one-third; but (4) protection to be given to the divers to ensure that they receive as good a price for their oysters as does the Government. (5) Limitation of the fishery season to the period between January 15th and May 15th. (6) No oysters to be fished of dimensions under five and a half inches, shortest diameter. (7) Further study of the life-history of the window oyster with a view to the stocking of other tidal lakes therewith, and the creation therein of pearl beds similar to those at Tampalakamam.

GENERAL NOTES.

Occurrence of Platinum in South Africa.—In October 1906 a sample of rock was received at the Imperial Institute from Grahamstown. It was believed to contain some of the platinum group of metals, as well as niobium and tantalum, with possibly zirconium and thorium.

This specimen, and others which were subsequently forwarded from the same locality, consisted of earthy pyritic calcareous material, with, in some cases, decomposition products of an intrusive basic igneous rock. A careful examination was made of these specimens, which were stated to come from a locality in the Division of Albany, some twenty-five miles distant from Grahamstown, but they were found to contain only a trace of metals of the platinum group, too small in quantity to be of any commercial value.

Platinum, and its allied metals, though sometimes occurring in minute amounts alloyed with gold, are usually found in small nuggets and fine grains in the alluvium of districts where rocks rich in magnesia, such as peridotite and its alteration product serpentine, are undergoing erosion. These rocks, which are at the same time characterised by the presence of nickel and chromium minerals, appear to be the original source of platinum and its allies.

It was probably due to the presence of minerals rich in magnesia in the intrusive rock that the minute traces of the platinum metals in the Grahamstown deposits are to be attributed; but the peridotites and

serpentines of South Africa have not up to the present yielded these valuable metals in any appreciable amount.

Platinum has, however, been detected in South African chromite and in the nickeliferous pyrrhotite of Nyasaland. The latter finds an exact parallel in the platinum-bearing nickel ore of Sudbury, Ontario. For fuller information as to the occurrence of platinum, see this *Bulletin*, 1905, **3.** 135, 137; 1906, **4.** 167; 1907, **5.** 93, 189.

Fertility of Acid Soils.—In the *Proceedings of the Twenty-first Annual Convention of the Association of Agricultural Chemists of the United States* is given a "Summary of Experiments on the Relation of Soil Acidity to Fertility." These experiments have been carried out by means of pot cultures and field trials, and the following is a brief *résumé* of the more important results secured:—

The acidity of soils is due to several products, *e.g.* soluble and insoluble organic acids, readily decomposable silicates, etc., and for this reason it has been found impossible to judge of the relative fertility of two different soils of the same degree of total acidity, although it is clear that the fertility of any one soil increases in proportion to the decrease in acidity, when it is neutralised by gradually increasing quantities of lime. A soil completely neutralised by the addition of lime appears to render the crops grown on it less susceptible to fungoid diseases. Increased yield after liming is specially noticeable in the case of red clover, while this and other leguminous plants develop root nodules to a far greater extent in a neutral than in an acid soil; in fact, it has been found impossible to grow red clover on some acid soils under ordinary farming conditions without previous liming.

The mechanical condition of the soil also varies with the acidity, and generally speaking an acid soil is wetter and more inclined to become water-logged in the lower layers than an alkaline soil. A black humus sand was, when acid, very sticky and water-logged, while after neutralisation it was dry and in good condition although it had received more water, while plants grown on the acid soil were stated by an independent observer to be "over-watered." The lasting effect of lime in neutralising soil acidity has been investigated, but no very definite results have as yet been obtained. It has been found that even where as much as 150 bushels of lime per acre have been added within twenty years, with frequent ploughing to 8 or 9 inches, the lime has not penetrated to a greater depth than 12 inches.

Different crops affect the reaction of the soil to different degrees; thus oats followed by buckwheat rendered acid soils alkaline after six years, whilst beans followed by buckwheat rendered some originally alkaline soils acid in the same time. The causes of this are not yet known.

The principal conclusions arrived at are that neutral or slightly alkaline soils are more fertile and produce crops more economically than acid soils, and that to neutralise soil acidity it is necessary to apply

a sufficient quantity of lime and to plough in to the required depth. Any great excess of lime over that required to neutralise to a given depth should be avoided, as it may be detrimental to future crops.

The Breeding of Plants Suitable for Growth in Alkaline Soils.— Investigations are at present being carried on by the United States Department of Agriculture with a view to producing plants resistant to drought and to alkaline soils, and the following is a brief abstract of some of the more important results published in *Bulletin* No. 113 of the Bureau of Plant Industry, entitled "The Comparative Tolerance of Various Plants for the Salts common in Alkali Soils":—

The salts which exist in these soils are sodium carbonate and bicarbonate, with sodium and magnesium sulphate and chloride, all of which exert a more or less toxic action on crops grown on soils containing them. Work on this subject is complicated by the fact that the soils hardly ever owe their alkalinity to any single salt, but to mixtures of the salts in proportions which vary according to the locality.

So far most of the experiments have been carried out with solutions of a single salt, but experiments are now in progress with (1) mixed salt solutions; (2) water extracts from natural alkaline soils, and (3) with alkaline soils themselves; and although it is obvious that the results obtained with solutions of a single salt are not directly comparable with the mixed salt solutions in the alkaline soils, it is necessary to first investigate the influence of each salt separately.

The seedlings of the following eight plants, which are commonly grown on alkaline soils, have been experimented with—white lupin, alfalfa, maize, wheat, sorghum, oats, cotton and beetroot, and it has been found that seedlings from old seed are much less resistant than those from fresh seed; while different genera and species, and also different varieties, or even agricultural strains of the same species, vary very greatly in their power of resistance. This last observation seems to indicate the possibility of breeding plants suitable for cultivation on alkali soils by artificial selection.

With most of the plants experimented on, magnesium sulphate or chloride was the most, and sodium bicarbonate or chloride the least, toxic; with maize, however, the reverse is the case.

The addition of another salt, notably calcium sulphate, to the solution greatly decreases its toxicity; for example, the addition of an excess of calcium sulphate to magnesium sulphate renders the white lupin capable of resisting a solution containing forty times the naturally toxic amount of pure magnesium sulphate.

The results of these experiments should be of interest to cultivators in India and elsewhere, where large tracts of alkaline soils exist.

Use of Prickly Pear as Fodder.—The "prickly pears" belong to an extensive genus widely distributed in America and the West Indies. Many of the species have been introduced into Southern Europe,

Africa, Australia and elsewhere for the sake of their edible fruits, and also owing to their utility as hedge plants. All the species are more or less fleshy, especially while young, and most of them are armed with strong sharp spines.

The plants are available in large quantities in many countries, and in some of the Australian colonies have become a pest, so that some method of utilising them is highly desirable. The composition of the plants indicates that they should be fairly nutritious as feeding-stuffs for cattle, but a serious objection to their use as a fodder is the presence of the spines, which are not readily rendered innocuous.

A *résumé* of the methods available for this purpose, and a large number of analyses of prickly pear plants as grown in the Southern States are given in two *Bulletins* of the Bureau of Plant Industry (Nos. 74 and 102, Part 1) published recently by the United States Department of Agriculture.

The chemical composition shows that the feeding value of these cacti compares favourably with those of ordinary green fodders and root crops. Although the "cane cacti" have a higher feeding value than prickly pear, practical considerations relating to growth and ease of propagation render them of less value than the latter, except where they are naturally abundant.

With the exception of *Cereus giganteus* and *Echinocactus Orcuttii* and a few other rare species, the genus Opuntia supplies the material mostly utilised for fodder, and it is the flat-jointed forms which are principally employed in America. There are about five species in the cylindrical-jointed group which have been used with some success, namely, *O. imbricata* from Mexico, *O. arborescens*, *O. fulgida* and *O. prolifera* from the coastal regions of Southern California. Of these, probably the most valuable are *O. fulgida* and *O. imbricata.*

Opinions regarding the value of prickly pear as a fodder are very conflicting; but it appears to be generally regarded in the United States as best suited for use with richer material, such as bran and cotton-seed meal.

Various methods for rendering the spines innocuous are employed in the several cactus regions. The most common practice consists in singeing the spines over a brush fire, or in a less primitive manner by the use of a gasoline blast flame, such as is used by plumbers. A more efficient method, and one said to be used in Australia, is boiling or, preferably, steaming the prickly pear for several hours, thereby rendering the spines harmless. Chopping machines are also employed in Texas, the object in this case being to cut the prickly pear into such small pieces that the spines are made innocuous by abrasion. In New South Wales it is considered that the most practicable method is the conversion of the material into ensilage, since after a few months the spines become quite soft, and the ensilage is said to be both nutritious and palatable.

Experiments conducted in California have shown that by selection and crossing of cactus plants it is possible to produce a spineless variety

valuable as a pasture plant and having a feeding value about equal to that of lucerne.

Fibres from Southern Nigeria.—Several fibres from Southern Nigeria have been examined recently at the Imperial Institute, and although some of them were of comparatively little value, others were of promising quality. A brief description of these products is given below.

No. 1. "Lagbolagbo." Very narrow ribbons, which had a tendency to break into short pieces when combed. This product was not very strong, but might possibly find a market as a rope fibre. Value £22 to £24 per ton.

No. 2. *Sterculia Barteri* ("Eso"). This fibre somewhat resembled the preceding fibre, but was stronger, harsher and more woody. It would possibly find a market for rope-making at about £15 to £20 per ton.

No. 3. *Dombeya Buettneri* ("Ewe Ofo"). Narrow brownish ribbons, harsh, woody and rather weak, which tended to break up on hackling. Value £7 to £8 per ton.

No. 4. "Ahon Ekun." Very fine, jute-like fibre, of good length and fair strength, but rather harsh. Value £16 per ton.

No. 5. *Monodora brevipes* ("Lakosin"). Resembled "Lagbolagbo" (No. 1) in general appearance, but was shorter and inferior in colour.

No. 6. "Osepotu Dudu." Short, very narrow ribbons, soft and fairly lustrous, but weak.

No. 7. *Eriodendron anfractuosum.* A somewhat jute-like fibre, soft, fine, rather woody and uneven in strength. If a regular supply could be obtained it would probably be worth £18 to £19 per ton.

No. 8. *Grewia carpinifolia* ("Itakan Okere"). Narrow ribbons, woody and rather weak.

No. 9. *Hibiscus* species ("Ramo" or "Yemoro"). A fibre of fair colour and good length; a possible substitute for jute, but inferior to a sample of "Ramo" or "Ramma" fibre previously examined at the Imperial Institute. (Cf. *Bulletin*, this vol., p. 131.)

No. 10. Jute: *Corchorus capsularis* (red stem). This jute was of good quality, length, lustre and strength. Value about equal to that of "medium" Calcutta jute, which was then quoted at £14 to £15 per ton.

No. 11. Jute: *Corchorus capsularis* (green stem). This specimen was similar to No. 10.

No. 12. *Furcræa gigantea.* This fibre was of good length and quality, but rather weak and not very thoroughly cleaned. Probably worth about £25 per ton.

No. 13. *Agave rigida*, var. *sisalana.* Rather short fibre, fair colour, good strength, but not very thoroughly cleaned. Value about £28 per ton.

No. 14. *Sansevieria guineensis* ("Oja-ikoko"). Very fine fibre of good length, but weak, owing probably to over-retting. Value about £28 to £30 per ton.

No. 15. *Ramie.* Sample of degummed fibre. Of good quality, but not in the form required for the market, as manufacturers prefer to buy the scraped ribbons and "degum" the fibre themselves.

No. 16. *Pandanus candelabrum.* This material would be quite unsuitable for straw-hat manufacture, being too limp and very weak. If of better strength it might possibly be useful for tying purposes, but would only realise a very low price.

No. 17. "Esuya" or "Ilasa omode." Fine jute-like fibre, of fair length and strength, irregular brownish colour and fair lustre; not very well prepared. Value £10 per ton.

No. 18. "Akeri." Fine fibre of good length, uneven strength and fair lustre, somewhat harsh, rather tangled, and probably slightly over-retted. Value £13 to £14 per ton.

In all cases in which the systematic name of the plant producing the fibre was not known, it was suggested that herbarium specimens should be forwarded for identification.

Australian "Blackboy" or Grass Tree (Xanthorrhœa Preissii).—Fibrous material derived from the inner portion of the trunk of *Xanthorrhœa Preissii* has been received at the Imperial Institute from Western Australia with a request for information as to its possible utilisation for textile purposes, paper-making, or as a source of glucose.

The use of the inner part of the stem as a source of alcohol or as a cattle food has been discussed in a paper by Mr. E. A. Mann, Government-Analyst for Western Australia, published in the *Journal of the Society of Chemical Industry* (1906, **27.** 1076, and 1907, **28.** 139).

As a result of experiments carried out at the Imperial Institute in communication with commercial experts, it is concluded that the material is unsuitable for textile purposes; it is also unlikely to prove of value for paper-making, and as it is very fibrous and contains scarcely any albuminoid matter, it is not suitable for use as a cattle food, whilst in view of the cheapness of glucose and alcohol manufactured from low-grade starches, it is improbable that it would be a remunerative source of alcohol.

These conclusions are confirmed by those obtained independently by Dr. Voelcker (*Journal of the Department of Agriculture of Western Australia*, 1907, 514).

Hardwoods of Australia.—In this *Bulletin* (1907, **5.** 64) an account was given of the tests carried out by Mr. G. A. Julius, and published in two Government Reports on the timbers of Western Australia. A Supplementary Report has since been issued, entitled *The Physical Characteristics of the Hardwoods of Australia.* In the

previous note the difficulty of instituting strict comparison between the results of tests made at different times, often on a small number of specimens, and, what is of great importance, of varying degrees of dryness, was insisted upon. This difficulty was practically met with in the endeavour to compare the strengths of the woods of the western and eastern Australian states, and to overcome this a further set of tests on the most important hardwoods of the eastern states was made by Mr. Julius "in a manner exactly similar to and with the same appliances as were used in the tests of the Western Australian timbers," and the results are set forth graphically in the schedules and diagrams in this Report.

Mallet Bark as a Tanning Material.—During the last few years this Australian tanning material, which is the bark of *Eucalyptus occidentalis*, Endl., has been successfully introduced into European markets. The tree is widely distributed in the southern parts of Western Australia, and penetrates eastward as far as the Coolgardie and Dundas gold-fields. Locally the tree is termed the "flat-topped Yate." It reaches an average height of 70 to 80 feet. The bark, as removed from the tree, is covered with a rough, dark-coloured outer cortical layer, which is removed previous to exportation.

Reference has been made already in this *Bulletin* (1905, **3.** 69) to the rapid development of export trade in this bark. Since 1903 large quantities have been exported to Europe from Australia, and especially to Germany. In 1904 about 3,000 tons were exported, of which 2,600 went to Germany, and in 1905 this had risen to 16,000 tons, of which Germany imported 15,000 tons.

Owing to the indiscriminate destruction of the mallet forests, which took place when the value of the bark was first recognised, the West Australian Government has found it necessary to draw up regulations for the stripping of the bark. This may now only be done by licence, and over restricted areas, during the months of July to December. Unfortunately, these regulations have only come into force after considerable damage has been done.

As it comes into commerce mallet bark is generally in the form of small pieces 2 inches to 1 foot in length, and varying from light to dark brown in colour. The fracture is very characteristic, and shows the interstices and hollows filled with a tannin-like incrustation, and which, in fact, comprises nearly the whole of the tannin content of the bark. This peculiar extract-like substance is analogous to ordinary Australian or eucalyptus kino, but is paler in colour. The colour of the bark is dependent to some extent on the method of preparation and packing. If the latter operation is conducted before the bark is properly dried fermentation takes place, and the colour darkens considerably. In addition to this there is a certain actual loss of tannin due to the heat developed.

The average composition of mallet bark is as follows :—

		Per cent.
Matter soluble in water	Tannin	42·0
	Non-Tannin	8·0
Matter insoluble in water		35·5
Moisture		14·5

though commercial samples may show from 31 to 50 per cent. of tannin, and from 5 to 10 per cent. of non-tannin matter.

Mallet bark is, therefore, one of the richest tanning materials, and with the exception of myrobalans and mangrove bark it is also one of the cheapest. It is especially suitable for the preparation of tanning extracts, owing to the high content of tannin and the easy solubility of the latter in water. Indeed an extract of the maximum strength can be readily made at much lower temperatures than is usually necessary, and such extracts when carefully prepared remain clear, and deposit little or no insoluble matter on cooling.

The bark produces a good but rather harsh leather of a colour similar to that given by oak bark, but after being stored for some time it is stated to darken somewhat in colour. The low content of non-tannin matter places mallet bark at a slight disadvantage as a tanning material for sole leather. For thick leathers the formation of acetic and lactic acids is necessary to induce swelling, and these cannot be produced unless a sufficient quantity of sugar is present as a raw material for fermentation. In using mallet bark for sole leather it is, therefore, necessary to add another agent richer in soluble non-tannin matter, or else a certain portion of the acids themselves.

The advisability of introducing the tree yielding mallet bark into the British and German East African Possessions is said to be under consideration, but no information is yet available as to whether or not this tree will grow well in these localities.

Export of Tanned Skins from India.—Some interesting figures are quoted by the *Leather Trades' Review* (1908, **51**. 295) with regard to the quantity of tanned skins exported annually from British India. Most of these come from Bombay and Madras, and are sold on the London market. In 1907 over 8,000,000 goat-skins and nearly 7,000,000 sheep-skins were sold in London, and another 3,000,000 were disposed of in the United Kingdom, the Continent and the United States. These figures are stated to be exclusive of direct shipments and of dry and pickled skins, large quantities of which are taken by the United States for the chrome leather industry.

The Indian tanned skins are applied to a great variety of purposes. The shoe trade absorbs a large proportion, and considerable quantities are also used in the production of fancy leather articles and in bookbinding.

Resources of the Seychelles.—Some further information, supplementing that given on this subject in the previous number of this *Bulletin*

(p. 107), is contained in the Annual Report on the Seychelles [Cd. 3729–31] issued recently. From this it appears that vanilla has again taken first place in the exports from the Islands, owing to a considerable rise in the price obtained for this spice. Thus in 1906 the average price obtained was 5·95 rupees per lb., whereas in 1907 it was 15·02 rupees, which is the best recorded since 1901. The value of cocoanut produce exported rose from 432,474 rupees in 1906 to 770,630 rupees in 1907, but as these products go chiefly to Marseilles, copra is increasing at the expense of cocoanut oil. As evidence of the growth of the newer industries to the inception of which attention was more especially directed in the previous article, the following statistics of exports for 1907 may be quoted:—

	Quantity.	Value. Rupees.
Mangrove bark	132 tons	3,049
Guano	13,198 tons	395,630
Essential oils	162 litres	2,384

It is mentioned that the distillation of essential oils is being seriously taken in hand, and small quantities of cinnamon bark and leaf oils, clove-leaf oil, lemon-grass and citronella oils, have been placed on the market, whilst the cultivation of ylang-ylang and cardamoms has been undertaken by several planters. In an appendix to the Report the Curator of the Botanic Station gives a *résumé* of the experiments with various products undertaken during the year, which includes manuring trials with vanilla, the preparation of essential oils, particularly cinnamon bark oil, tapping experiments on Para rubber trees, and work on the destruction of insect pests.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

MINING OPERATIONS IN THE PROVINCE OF QUEBEC FOR THE YEAR 1907. By J. Obalski, Superintendent of Mines. Pp. 61, with ten reproductions of photographs. (Quebec: Department of Colonisation, Mines, and Fisheries, 1908.)

This publication contains a brief account of the progress of the mining industry in the Province. In the case of iron ore operations are confined mainly to the bog ore, though deposits of magnetic sand of some value appear to occur. Chrome iron ore is also worked. Copper ore occurs in many localities, but the output is still under 30,000 tons. Gold is met with in the Chaudière valley, where the rock is composed of Cambrian and Præ-Cambrian schists traversed by diorites. A considerable amount was obtained in former years from the alluvium.

Recently quartz veins with visible gold have been discovered in Marston, but it appears to be very irregularly distributed.

The asbestos industry at Black Lake and Thetford is in a prosperous condition, and in consequence of the demand for asbestos fibre the Broughton serpentine district to the north-east has acquired some importance, in spite of the fact that there is but little "crude" material, viz. asbestos of good quality occurring in broad veins. It is stated that both "crude" and mill fibre, as well as the impure material known as asbestic, are also produced at Danville, to the south-west of the main deposits.

A considerable amount of "amber mica" and phlogopite was raised in the Province, but there was a temporary failure of the demand towards the end of the year. A small quantity of phosphate (apatite), which often accompanies the mica, was produced at the same time.

Little was done in graphite mining, only two companies working on the Buckingham region, and one in the Grenville district.

Combustible natural gas has been struck by boring in a number of localities in the St. Lawrence valley, and it is supplied for lighting and heating purposes to Three Rivers and other towns in the neighbourhood.

Among economic minerals which have not yet proved of commercial importance may be mentioned felspar, barytes, talc, molybdenite, bismuth, nickel and cobalt ore and magnesite.

The building materials which are produced in the Province include slate, granite, bricks, limestone and portland cement. The last appears likely to form the basis of an important industry.

The maps which are stated to accompany the report have apparently not been published.

GRAPHITE: ITS PROPERTIES, OCCURRENCE, REFINING AND USES. By Fritz Cirkel, M.E. Pp. 307, with numerous photographs, diagrams and maps. (Ottawa, Canada: Department of Mines—Mines Branch, 1907.)

The subject of graphite, its characters and applications has already been dealt with at some length in this *Bulletin* (1906, **4**. 353, and 1907, **5**. 70).

In the present work, after describing the chemical and physical characters of the mineral and its usual modes of occurrence, the author gives a detailed account of the deposits in Canada, especially those in Quebec and Ontario, and the mining and milling to which they have given rise. In addition to the localities mentioned in this *Bulletin* reference is made to deposits at Alkow Harbour, Dean Canal, on the coast of British Columbia; and Cumberland Sound, on the north side of Hudson Strait. Information is also given with regard to its occurrence in other parts of the world.

The particular qualities of graphite, which are required for various purposes, are next described, with especial reference to Canadian produce, which is stated to be equal in quality to that from Ceylon; and at the

same time details are given of the methods employed for determining the purity and quality of the mineral.

A chapter is devoted to statistics of the output and consumption in different countries. The Canadian output is at present comparatively small. It reached 2,210 short tons in 1901, but fell to 452 tons in 1904, and in 1907 was still only 579 tons.

Nearly seventy pages are given to the methods of dressing and refining the mineral, the Bohemian, Bavarian and United States practice being chiefly followed. The remainder of the book deals with the commercial applications of graphite, the manufacture of crucibles and pencils being described in considerable detail.

It is to be hoped that this work will stimulate the graphite industry in Canada, which appears to be capable of considerable development.

Practical Coal-mining. By Leading Experts in Mining and Engineering, under the Editorship of W. S. Boulton, B.Sc., Divisional Volume 5. Pp. vi + 176. (London: The Gresham Publishing Co., 1908.)

The previous volumes of this handsome work have been already reviewed in this *Bulletin* (1907, **5**, 197, 316 and 449; 1908, **6**. 91).

The present instalment comprises a readable article on safety lamps by Mr. James Ashworth, who devotes considerable space to an historical survey of the subject. It is followed by an article on colliery explosions and rescue appliances, by Professor W. Galloway, which is clearly written and appears to contain a satisfactory exposition of the subject. There is an unfortunate misprint on page 61, where it is stated that a mixture of air and marsh gas containing 9·5 per cent. of air is required for complete combustion. It should obviously be 9·5 per cent. of marsh gas.

In his article on mineral holdings Mr. H. F. Bulman goes out of his way to advocate at some length the advantage of vesting minerals in the surface owner instead of reserving them for mining enterprise, which is the policy adopted in most countries, including India, except Bengal, where, however, most of the more important coal-fields are situated. He contends that private ownership has not checked the development of the coal industry. However this may have been where there were surface outcrops, the difficulty of negotiating with numerous landowners has seriously discouraged the prosecution of deep borings, the cost of which can only be recouped by the exercise of extensive mining rights.

The volume concludes with the commencement of an article on mine surveying by Mr. L. H. Cooke, lecturer on mine surveying at the Royal School of Mines, London. In the present instalment he describes the instruments employed, devoting special attention to the adjustment and manipulation of the theodolite and its preservation from injury. A number of practical hints are given, which should prove invaluable to the young surveyor.

In connection with the miner's dial he describes in some detail the

errors which may occur from variations in the magnetic meridian, or the proximity of iron or iron ore.

Like its predecessors this volume is excellently illustrated with diagrams and reproductions of photographs.

INSECTS INJURIOUS TO VEGETABLES. By F. H. Chittenden, Sc.D. Pp. xiv + 258. (New York: Orange Judd Co. London: Kegan Paul, Trench, Trübner & Co., Ltd., 1907.)

The importance of a widespread knowledge of insect pests is obvious to all who are cognisant of the enormous annual losses caused to agriculturists in every part of the world by the depredations of these animals. In the volume under notice the author, well known for his contributions to the entomological literature of the United States Department of Agriculture, has considered, probably for the first time as a special topic, those insects which attack a class of crop peculiarly susceptible to their ravages, and commonly included under the comprehensive title of "vegetables."

The author has treated his subject in a manner which is at once clear, concise and practical. The first five chapters, occupying nearly one-half of the book, may be described as an epitome of the principles of economic entomology. They deal with such matters as the classification of insects, the economic value of a knowledge of scientific entomology, farming methods which involve minimum risk of insect attack, methods of combating the pests, and the uses and practical application of insecticides.

The specific pests are dealt with in alphabetical order of the crops concerned. The insects described are, of course, primarily those of importance in America, but, unfortunately, a very large proportion of those dealt with are well known to farmers and market-gardeners in this country. The crops treated of are asparagus, beans and peas, beet and spinach, cruciferous crops, cucumbers and melons, potatoes, tomatoes, and a series of miscellaneous crops. In dealing with the notorious Colorado beetle, affecting the potato plant, attention is drawn to the fact that it was owing to the disastrous scourge of this pest in America in the middle of last century that the valuable insecticide known as "Paris green" was first used in connection with edible crops.

The book is well illustrated, largely with the author's own drawings from the publications of the United States Department of Agriculture, and concludes with a selected bibliography on insect pests, which should prove very useful to those desiring further information on particular subjects.

WOBURN EXPERIMENTAL FRUIT FARM. Seventh Report by the Duke of Bedford, K.G., and Spencer U. Pickering, F.R.S. Pp. 56. (London: Eyre and Spottiswoode, 1907.)

The report this year deals with the question of pruning fruit trees, and the circumstances under which it is beneficial and under which it is

harmful. The results described in the fifth report indicated that the less a healthy, well-established tree was pruned the greater was its size, as well as the yield of fruit from it; the results of subsequent observations and measurements are now discussed, and are found to support this conclusion, but the inference must not be drawn that all pruning should be abandoned.

In the case of apple-trees, which are the fruit trees chiefly dealt with in this report, it was found that at the end of twelve years, the trees then being fifteen years old, those which had not been pruned at all were 20 per cent. heavier than those which had been moderately pruned, whilst those which had been hard pruned were 16 per cent. lighter. When similar branches on the same tree were pruned, the less the pruning the greater was the number, length and weight of the new shoots, and the greater also was the increase in girth of the branch. From every point of view, therefore, the pruning of a *healthy, growing* tree seems to be adverse to wood formation.

As regards the crops, too, the reduction of pruning shows to great advantage. With dwarf apple-trees, during the first five years the crops from the unpruned trees were more than twice as great as from the moderately pruned ones, and more than three times as great as from the hard-pruned ones. In the second five years the differences were still greater. Similar results were obtained during a recent season with trees of different varieties, on crab and paradise stock, the crops from moderately and hard-pruned trees being in the proportion of three to one in both cases. Further, there was no appreciable difference in the size of the fruit from trees pruned to different extents, so that the values of the crops were proportional to the weights. The trees, however, were not allowed to over-bear, the fruits being thinned to two to the truss. Confirmatory evidence of the antagonism of pruning to fruiting was obtained by counting the fruit buds formed on similar branches of the same tree which had been cut back to different extents.

In discussing the circumstances in which pruning is to be recommended, it is pointed out that all the above results refer to healthy trees still young enough to be growing vigorously. With a tree which is older and has attained maturity the results are somewhat different—not as regards fruiting, but as regards branch formation. With such a tree branch formation under natural conditions has ceased, but if it be pruned, new branches are formed to supply those removed; they are formed, however, only at the expense of the fruit.

What applies to a tree which has passed the age of active growth and has reached maturity applies to a tree which has become stunted, or has had its growth arrested by root injury, as, for instance, when it has been transplanted. The deficiency of vigour of a freshly-planted tree is shown by the small size of its leaves and the tendency to form fruit-buds instead of wood. The correction for fruiting is hard pruning, and it is therefore most important that freshly-planted trees should be cut back hard, so as to prevent precocious fruiting, which would generally result

in permanent stunting. The results of overbearing are well known; when carried to excess with a young tree, the tree is stunted and ruined, and even in less serious cases there is weakening and distortion of the branches, causing loss or injury to the crop before it can be harvested.

Pruning to a certain extent is also desirable in order to obtain a compact and shapely tree, and branches that cross or rub each other and any unripened wood should be removed. Precocious and weak-growing varieties will require more pruning than trees which are growing freely and are properly tended in other respects; the latter require very little pruning to keep them in shape. Standards, too, require more pruning than dwarfs in order to obtain a strong stem and a compact head before any heavy crops are borne.

The Woburn experiments and the full discussion of their results, of which the above is a brief summary, throw great light on the principles which should guide the fruit-grower in the management of his trees.

ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, ONTARIO, 1906. Vol. I. (Toronto: U. K. Cameron, 1907.)

Summaries of results in some of the many branches of work carried on by the Ontario Department of Agriculture are gathered together in this bulky volume, which includes some twelve separately-paged annual reports. The range of subjects dealt with is very wide, as, in addition to the direct work of the department itself, there are reports on bodies acting in close co-operation with it, such as the associations of breeders of cattle, sheep and swine, the dairymen's and poultry associations, the Poultry Institute, agricultural societies, as well as a report on the provincial winter fairs and the results of a special investigation on horse breeding.

The report, occupying some 200 pages, on the Ontario Agricultural College and Experiment Farm gives a good idea of the diversity of the subjects dealt with at the institution in a practical manner, and with special reference to local agricultural practice.

Co-operation between the actual agriculturists and the Central Government Department is extensively practised in Ontario, as indicated by the associations referred to already. The Agricultural and Experimental Union affords an excellent example. The Union was formed in 1880 to secure co-operation in experimental work, and now has working members in every part of the province. As one instance of its usefulness, it may be noted that through its help seed of improved varieties of plants, raised by careful selection at the Agricultural College, is distributed and given a trial in the various districts, and many standard varieties of grain, grass, etc., now in general cultivation throughout the province were brought to the homes of the farmers through this phase of experimental union work.

REPORT TO THE GOVERNMENT OF INDIA, CONTAINING AN ACCOUNT OF THE RESEARCH WORK ON INDIGO PERFORMED IN THE UNIVERSITY

OF LEEDS, 1905–7. By W. Popplewell Bloxam, B.Sc. (Lond.), F.C.S., F.I.C.; with the assistance of S. H. Wood, B.Sc. (Lond.); I. Q. Orchardson, B.Sc. (Aberdeen); R. Gaunt, Ph.D. (Berlin), M.Sc. (Leeds); and F. Thomas, B.Sc. (Manc.); and under the general supervision of Mr. A. G. Perkin, F.R.S., of the University of Leeds. Pp. 117. Published by order of His Majesty's Secretary of State for India in Council. 1908.

The importance of the indigo industry to India is shown by the fact that from 1891 to the end of the century the value of the indigo exported per annum ranged from a maximum of £3,570,000 in 1895–6 to a minimum of £1,424,000 in 1900–1, the area under this crop being often considerably over a million acres. Various methods have been devised for preparing the same dye from the by-products of the manufacture of coal gas, and in the last years of the nineteenth century the competition of the dye prepared in this way began to be feared, and has induced the Indian planters, with assistance from the Bengal Government, to call in the aid of scientific investigation to save their industry from extinction.

In dealing with the questions that presented themselves in this inquiry, one pressing need was to obtain satisfactory analytical control over the value of the crop in the field, and over the process of manufacture by which the indigo is obtained from the plant. This required the solution of two analytical problems: (1) how to find the amount of "indigotin" in the finished product; (2) how to find the "indigotin value" of the plant. It may be explained here that "indigotin" is the name given to the blue colouring matter to which the commercial product, indigo, mainly owes its value; and, further, that the plant does not contain indigotin, but a substance, "indican," belonging to the class of glucosides, which is decomposed in the process of manufacture, yielding indigotin. The "indigotin value," then, represents the quantity of indigotin that could be obtained from 100 parts of the plant if the indican were to yield the full amount of indigotin without waste or loss.

These problems were far from being easy to solve, and although the methods employed by various analysts have been constantly improved, none were perfectly satisfactory. In the first problem this was due to the errors produced by the impurities that always accompany the indigotin. Mr. Bloxam set himself the task of remedying this, and has devised a method whereby the indigotin is separated from the impurities by conversion into a compound, potassium indigotintetrasulphonate, which can be separated by filtration and washed, after which the amount of indigotin can be readily found with exactness, since interfering impurities are no longer present. To make this last determination it is necessary to have a sample of indigotin in a state of purity as a standard, and Mr. Bloxam and the other authors have worked out a method of obtaining this. As regards the second problem—namely, how to find the indigotin value of the plant—a method suggested by

Beijerinck involving the use of isatin was examined and worked out by the authors, and found to be accûrate.

The greater part of the Report is taken up with accounts of the work of the authors on these two problems, and with examinations of the various substances that accompany indigotin in commercial indigo, and on various other points. At the end of the book is given an account of the field experiments on indigo conducted in India; but it is shown that, as the new method of determining the indigotin value of the leaf had not then been worked out, these experiments do not afford nearly as much guidance as is desirable as to the efficacy of different manures and of the manufacturing processes. As the indigotin value of the whole plant (leaf and stem) is supposed to be less than 1 per cent., it can be easily seen how much in the dark any agricultural work must be when this value is not exactly known. It is to be hoped that now this value can be determined by analysis, field and manufacturing experiments will be continued under scientific supervision, and that they will point out the way to the most profitable procedure in the field and manufactory.

HANDBOOK OF INDIAN AGRICULTURE. By Nitya Gopal Mukerji. Second Edition. Pp. xii + 706. (Calcutta: Thacker, Spink & Co., 1907. Price 10*s.* 6*d.*)

The distinguishing feature of this book is the wide range of subjects covered. Indian agriculture, using the term even in its narrowest sense, offers a very broad field, and when, as is the case here, the author in addition treats of geology and formation of soils, implements, methods of chemical analysis of farm products, manures and water, stock, sericulture and the lac industry, insect and fungoid pests, and lastly, famines, his work becomes almost encyclopædic in its scope. The book appears from the preface to have had its origin in lectures given at the Sibpur Civil Engineering College, at which institution the author was Professor of Agriculture and Agricultural Chemistry at the time of his death. The mode of treatment is in most cases to explain the principles of the subject before passing on to the description of practical methods. Thus, in the section on implements, the theories underlying cultivation are dealt with before the various types of ploughs and other agricultural appliances are described. Similarly, an exposition of the theories underlying the question of irrigation precedes the chapter on contrivances for raising water. The largest section, on crops, affords a useful summary of information respecting the multifarious economic plants of India, and much of it would be of interest and, with modification due to varying local conditions, of practical utility in other countries also. Care must be taken, however, not to rely too implicitly on all the data, for even if in all the cases they are strictly accurate, so far as India is concerned, they do not necessarily hold for other regions. Thus, in the chapter on rubber, it is stated that Para rubber (*Hevea brasiliensis*) is fit for tapping fifteen

years after planting, whereas in Ceylon and the Malay Peninsula about half this period is the usually recognised time of waiting.

Mistakes in botanical names are more numerous than they should be. Thus, in the rubber chapter, to go no further, *Enconia illinoides* occurs twice where *Eucommia ulmoides* is meant, and the fruits of the plant are alone referred to as yielding rubber. The use or otherwise of capital letters in the specific names would appear to have been left to the discretion of the printer. The aid of a botanist in looking over the proofs of the next edition would easily rid the book of these too obvious blemishes.

Taking the book, however, as a whole, it is a welcome addition to the literature on Indian agriculture, and will doubtless be of great service to those who desire to get, within the compass of a single volume of moderate size, a general summary of the plant and animal industries of that vast region.

CEYLON. A Handbook for the Resident and the Traveller. By J. C. Willis. Pp. 247. (Colombo, 1907.)

Until quite recently general information about Ceylon had to be gleaned from such books as Tennent's classical *Ceylon*, published in 1859; Ferguson's annual *Ceylon Handbook and Directory;* the special handbooks prepared for great exhibitions, *e.g.* Paris and St. Louis; and a number of miscellaneous volumes, each dealing principally with one or more sections of the great stock of accumulated knowledge concerning the premier Crown Colony of the British Empire. There was, however, no comprehensive modern handbook useful alike to those who dwell in the island and to tourists. To remedy this want has been Dr. Willis's aim in producing this volume. The four principal sections are devoted to physical features and natural resources, history, people and archæology, a descriptive account of the country, and sport—and the book thus obviously embraces within its scope most of the topics of interest. In addition, a final section gives useful information on colloquialisms, notes on health and clothing, and some references to existing literature. The book is provided with maps, and is freely illustrated. It is a little disappointing, however, to find so many very familiar illustrations of Ceylon doing service again, but considerations of expense are doubtless responsible for this, and the book is produced at a low price.

As might be expected from the author's position as Director of the Royal Botanic Gardens, the portion on botany, vegetation and agriculture affords a very reliable survey of the plant resources of the Colony, and it is interesting to note in passing how greatly Ceylon owes her prosperity to exotic plants introduced by the Botanical Department.

As a general handbook to Ceylon the book will, as already indicated, be of value, whilst the special section giving notes on scenes of interest along the lines of railway, and the alphabetical gazetteer to the chief towns, villages and planting districts, will, in particular, be the

means of making the stay of tourists in the island more enjoyable and more profitable.

THE BOOK OF CEYLON. By Henry W. Cave, M.A. Pp. xii + 664. (London, Paris, New York, Toronto and Melbourne: Cassell & Co., Ltd., 1908. Price 12*s*. net.)

The dearth of modern general works on Ceylon has been put an end to, not only by Dr. Willis's book already noticed (see above), but by the volume now under review. Mr. Cave has published previously works dealing with some of the interesting features of Ceylon, *e.g.* amongst others *Golden Tips*, a popular account of the tea industry, and *The Ruined Cities of Ceylon.* Now he has produced a book dealing with Ceylon generally, being, as the sub-title states, a guide to its railway system and an account of its varied attractions for the visitor and tourist. The author's skill as a photographer, already well known, is again amply demonstrated by the reproductions of some 750 photographs, which are of great value and interest to all who know Ceylon, and will enable others to obtain, so far as pictures serve the purpose, a very good idea of Ceylon life and scenery. The letterpress is by no means subordinate to the illustrations, and, in addition to affording the information expected from the title, gives incidentally good short summaries on many matters of economic interest. In addition to the photographic illustrations there are numerous maps and plans. For the convenience of travellers who may not wish to carry about with them daily the complete, somewhat bulky volume, it may be noted that the book is published also in three separate parts, dealing respectively with (1) Colombo, the S.W. coast and the Kelani Valley; (2) Kandy and the Highlands; and (3) the Northern Provinces.

SOUTH AFRICA AT HOME. By Robert H. Fuller, M.A. Pp. xiii + 236. (London: George Newnes, Ltd.)

The aim of the author, who was formerly the headmaster of the Dale College, King William's Town, has been to present an account of life in South Africa. Sir Thomas Fuller, until recently Agent-General for the Cape of Good Hope, says in the course of an appreciatory introduction, the book "passes by the conflicts and controversies—political, racial and social—which have troubled South Africa for so many years, and essays to give a picture of the people in town and country—'dwellers at home' and wanderers under 'hoop and tilt.'" The varying conditions of life in the states which together make up South Africa are sketched in an interesting manner. Industries and other matters of economic importance are well dealt with, as instanced by the chapters devoted respectively to trade routes, life on the farm, occupations and industries. The book makes no pretence to deal other than lightly with the topics under discussion, and perhaps for this very reason it will serve a useful purpose in interesting many who

would be deterred by publications cast in a severer mould. Several of the illustrations, it may be noted, deal with scenes of economic interest.

KELANTAN: A STATE OF THE MALAY PENINSULA. A Handbook of Information. By W. A. Graham. Pp. xi + 139. With illustrations and a map. (Glasgow: James MacLehose & Sons, 1908.)

The appearance of this handbook dealing with Kelantan is very opportune, as, owing to agreements recently concluded between Great Britain and Siam, it is probable that the near future may witness considerable developments in the trade and natural resources of this little-known country.

The suzerain rights over Kelantan possessed by Siam are held on the understanding that a British adviser shall reside at the Court of the native ruler to assist in all matters of administration other than those touching the Mohammedan religion. In July 1903 the author of the volume under review was appointed Resident Commissioner and adviser to H.H. the Rajah of Kelantan, with Mr. H. W. Thomson as assistant.

Kelantan is the largest of the Malay States subordinate to Siam. It is situated on the east of the Malay Peninsula, facing the China Sea, and north of the Federated Malay States. The area is estimated at about 5,500 square miles, or about equal to half that of Belgium. The population is given as rather over 300,000; the capital, Kota Bharu, contains about 10,000. Along the 60 miles of coast-line the land is flat and low-lying, intersected by numerous tidal creeks which connect the different rivers. Behind extends for from 10 to 25 miles inland a great and fertile plain, surrounded by stretches of less open country with isolated hills, which, towards the south, become wild mountain masses, culminating in Gunong Taban, some 8,000 feet high. The climate is mild and equable, the temperature rarely falling below 60° F., and never rising above 93° F. The average daily range of temperature is 14° F. The average rainfall for the past three years shows 102 inches for the hills and about 104 for the plains. The driest months are February, March and April, when the rainfall seldom exceeds 2 inches per month.

The waterways are the principal means of communication in the State, and some 6,000 craft of from 60 to 70 tons are shown on the Government registers. The making of roads has not yet progressed far beyond the capital, consequently there is practically no wheeled traffic.

The principal source of wealth consists in agricultural products. Some 450,000 acres of land are at present under cultivation, and about 21,700 acres have been taken up for rubber cultivation, but there still remain rather over 3,000,000 acres of waste land, of which at least a third is capable of cultivation.

Of rice, the principal crop, some 70,000 tons are produced yearly, sufficient to feed the whole population and to provide 4,000 or 5,000

tons for export. The coconut palm comes next in order of importance, the number of trees actually bearing being estimated at 500,000, while quite as many again have been planted recently, both copra and nuts being exported. The coir is neither used locally nor exported at present, but simply wasted.

The betel-nut palm thrives in the interior, and large quantities of the nuts are annually exported to Singapore.

A small quantity of pepper is grown, and in the author's opinion such crops as gambier, tapioca and sugar would do well were less primitive methods of cultivation adopted. Considerable attention is now being devoted to rubber, and in view of the success which has attended the plantations in other parts of the peninsula it is reasonable to anticipate a similar success in Kelantan.

In addition to several valuable timbers the forests yield wild rubber (*Ficus elastica*), gutta-percha (*Dichopsis Gutta*), several resins of the type known commercially as damars, also rattans and bamboos.

Extensive stretches of pastoral country support large numbers of live-stock, comprising about 20,000 buffaloes, 90,000 head of ordinary cattle, in addition to sheep, goats and poultry.

Kelantan is believed to be rich in minerals, but its resources in this connection have hitherto remained undeveloped. Gold is mined to a certain extent, and the exports for 1906–7 were valued at about £25,000.

The book contains about 60 plates illustrating the scenery of the State, native costumes, agriculture and recent developments in the planting and mining industries. Forming an appendix is a series of tables giving in a concise form a summary of the contents. The facts quoted above are sufficient to indicate the more important natural resources of the country, and Mr. Graham's book should be useful in directing attention to it as a new field for development.

HANDBOOK OF THE PHILIPPINES. By Hamilton M. Wright. With three new maps, and 150 illustrations from photographs. Pp. xvii + 431. (Chicago: Messrs. A. C. McClurg & Co., 1907.)

The object of this work is to depict the Philippines and their inhabitants as they appear after having been under the influence of the United States of America for nine years. The author has travelled for many months in the interior of the archipelago, and has personally collected a large part of the information presented.

The book contains an account of the position, size, climatic conditions and history of the islands. The character, customs, industries, manufactures, religion, laws and government of the inhabitants are also dealt with. Special chapters are devoted to agriculture, hemp-growing and the tobacco and sugar industries. The opinion is commonly held that tobacco is the most profitable crop to the Philippine planter, but in commercial importance it ranks third, the value of this crop being exceeded by those of hemp and sugar. In 1906 the value of the

exports of Manila hemp amounted to 60 per cent. of the total, the value of the sugar exported was 14 per cent., whilst that of tobacco was only 8 per cent., consisting of unmanufactured tobacco 5 per cent., and manufactured tobacco 3 per cent.

The work is written in an interesting manner, is well illustrated, and not only affords an insight into the industrial and commercial position and prospects of the islands, but also contains useful information for tourists.

THE BRAZILIAN YEARBOOK. Issued under the patronage of the Brazilian Government. First Issue. Compiled and edited by J. P. Wileman. Pp. xxiv + 779. (Rio de Janeiro: Offices of *The Brazilian Yearbook*, 42 Rua Visconda da Inhauma; and London: Messrs. McCorquodale & Co., Ltd., 1908.)

This volume should be of the greatest value to all those having business with this great Southern republic. The earlier portion of the book is devoted to information of a general character, including a useful, but all too brief, description of the physical and geological features by Dr. Orville Derby, and an interesting article on the climate by Dr. Afranio Peixoto, who brings forward evidence to show that there is little fault to be found with it on the score of health, apart from the occurrence of such preventible diseases as beri-beri, malaria and yellow fever, which are rapidly diminishing as sanitary conditions become better understood. There is also an interesting account of the recent, apparently successful, attempt to steady the Exchange by the issue of notes convertible into gold at the rate of one milreis to fifteen pence sterling.

Then follow statistical details of the Brazilian trade, arranged by states, with a final summary for the whole country. Among the most important mineral exports are monazite sand (with an annual value of about £100,000 sterling), crystal (viz. quartz), manganese, carbonado or black diamond, diamonds and other unspecified precious stones. Mica and graphite are only exported in small amounts, but it seems probable from the character of the rocks that these may be found to be of more importance in the near future. Among agricultural products may be mentioned coffee, cotton, cotton seed, sugar and cocoa. Full information is also given of the revenue, expenditure and indebtedness of the whole country and the separate states.

The descriptions and historical accounts of the states leave much to be desired, and are of little value for commercial purposes. An exception may, however, be made in favour of an article on the mining conditions in the state of Minas Geraes. Reliable information is also given with regard to shipping and railways, and joint-stock companies working in Brazil. The book is illustrated by useful maps and diagrams.

NEW JOURNALS.

LES MATIÈRES GRASSES. Nos. 1 and 2. 1908. Paris Office, 49 Rue des Vinaigriers X^e. London Office, 6 Holborn Viaduct.

This new monthly journal deals with the technology and scientific investigation of oils, fats and waxes of vegetable or animal origin, of petroleum and its derivatives, and also of such materials as glue, gums, resins, paints, varnishes, colours, etc.

The staff of collaborators includes the names of many of the best-known authorities on these subjects in Europe.

In the first number, among other articles of interest the following may be noted: "On the Occurrence of *Allanblackia Sacleuxii*, Hua, in the French Congo." This tree yields an oil seed, and was apparently previously unknown in this part of West Africa. A short article dealing with the various species of *Pinus* utilised as sources of turpentine oil mentions the experiments made in India with *Pinus longifolia*, the turpentine oil from which is now under investigation in the Scientific and Technical Department of the Imperial Institute.

The second number contains an article on Crab or Carapa Oil by Dr. Lewkowitsch, in which are included analyses of oils obtained from the seeds of *Carapa grandiflora* from Uganda, forwarded to him from the Imperial Institute, and also the first part of an article on "Dika" butter.

Each number contains market reports and abstracts of French, German, British and other patents. The journal will be of value to all who are interested either in the scientific or technical aspect of the oil and related industries.

THE PHILIPPINE AGRICULTURAL REVIEW. Vol. I. 1908. Nos. 1 and 2. Bureau of Agriculture, Manila.

This new official publication is intended to supplement the bulletins issued at irregular intervals by the Philippine Bureau of Agriculture, its object being to keep planters and others in constant touch with the agricultural work of the Bureau—work of a scientific or technical nature being published in bulletin form as before. The first number contains reports of the work accomplished during the last twelve months, and serves to indicate the nature and scope of the agricultural and other investigations carried out by the Bureau. The second number contains two general articles on agriculture in Porto Rico and the province of Nueva Ecija respectively, as well as an account of investigations with various fodder crops.

COLONIAL PUBLICATIONS.

Copies of the following publications, descriptive of the resources of British Colonies and Dependencies, have been received recently. They are available for distribution at the Central Stand in the Exhibition Galleries, free of charge, so long as numbers permit.

Canada.

PRINCE EDWARD ISLAND. Canada's Garden Province. Pp. 32. Published under the direction of the Minister of the Interior.

Prince Edward Island is both the smallest and the most densely-populated province of the Dominion. An account is given of its capabilities, especially in agricultural products, and attention is drawn to the fact that owing to the attractions of the western movement in Canada, farms in Prince Edward Island are at present available to purchasers at comparatively moderate rates.

ONTARIO. Handbook of the Province. Prepared by direction of the Minister of Agriculture, Ontario, 1907. Pp. 151.

The volume gives a good general account of the resources and products of Ontario. Climate, cities, towns, manufactures, minerals, forest wealth, agriculture are the subjects of some of the principal sections. Illustrations are numerous, many of them of various farm operations, packing for export, dwelling-houses, and other matters of practical interest.

SASKATCHEWAN. Final Report on the Grain Crops for 1907. Bulletin No. 6 of the Bureau of Information and Statistics, Department of Agriculture. Pp. 32.

The province of Saskatchewan has a land area of 242,332 square miles, or 155,092,480 acres. Of this total some 3,058,917 acres, or 4·18 per cent., were under cultivation in 1907. For crop-statistics purposes the province is divided into twenty-one districts, the boundaries of which are indicated on a map. Returns are given showing the area, total yield and the yield per acre for the principal crops in each district for the years 1905, 1906, 1907. The climatic conditions for each month are also recorded.

NOVA SCOTIA, AN ADDRESS ON. By Mr. J. Howard, Agent-General for the province. Pp. 46.

The address, given originally in 1902, and now revised to 1907, affords a general idea of the history, natural resources and capabilities of Nova Scotia. A special section is devoted to information for intending emigrants. The pamphlet is illustrated.

NOVA SCOTIA. Report of the Secretary of Industries and Immigration, 1908. Pp. 24.

This is the first report on an official bureau founded in October 1907

to make known the attractions the country offers to tourists, the opportunities for permanent settlement, and to assist in the distribution of immigrants on arrival. The report describes the means adopted and the results achieved in co-operation with the Agent-General and the Salvation Army in London. A report is included on Nova Scotia's exhibit of apples at the Royal Horticultural Society's Fruit Show, 1907.

Australia.

MAP OF VICTORIA SHOWING POSITIONS OF BUTTER FACTORIES, with statistics of the dairying industry. MAP OF VICTORIA CLASSIFIED ACCORDING TO ITS PRODUCTIVENESS. The two maps are printed on one sheet. The second shows the distribution of sheep country, cattle country, land adapted for wheat, root-crops, fruit, vineyards and timber reserves in Victoria.

DAIRY FARMING IN VICTORIA, THE GARDEN STATE OF THE EMPIRE. Pp. 16. Bulletin No. 1. The pamphlet shows the growth of the dairying industry, which is at present only in its infancy, but capable of almost unlimited expansion. The export of butter has greatly increased during the last three years, and the first steps have been successfully taken to manufacture cheese and condensed milk and to open up a regular market for fresh pork, hams and bacon.

SOUTH AUSTRALIA AND ITS PRODUCTS. Pp. 24. The pamphlet, which contains photographic illustrations, deals chiefly with the agricultural resources.

WESTERN AUSTRALIA. CONDITIONS OF LANDS ELECTION: A BRIEF RÉSUMÉ OF EXISTING LAND LAWS. Pp. 8. The pamphlet gives particulars as to the area of land allowed to be held, free homestead farms, conditional purchase, grazing leases, working men's blocks, and other information for settlers.

RECENT REPORTS FROM AGRICULTURAL AND TECHNICAL DEPARTMENTS IN THE COLONIES AND INDIA.

In this Section of the Bulletin a Summary is given of the Chief Contents of Reports and other publications issued by Agricultural and Technical Departments, in the Colonies and India.

INDIA.

Annual Report of the Board of Scientific Advice for India for 1906–7. The Board of Scientific Advice for India was constituted in 1902 as a central authority for the co-ordination of official scientific inquiries, with

a view to prevent duplication of investigations and to secure, as far as possible, inter-departmental co-operation in inquiries of interest to more than one department. It consists of the principal officers of the various scientific departments in India, as well as certain other scientists in the service of the Imperial or Provincial Governments, and acts in consultation with an Advisory Committee of the Royal Society, through the Secretary of State for India.

The Annual Report, of which that now under notice is the fourth of the series, gives a short *résumé* of the proceedings at meetings held by the Board, but is mainly occupied by summaries of work accomplished during the year in the various branches of scientific investigation carried on officially in India, viz. economic and agricultural chemistry, astronomy, meteorology, terrestrial magnetism, geodesy, geography, botany (including the botanical survey and botany as applied to agriculture and forestry), zoology (including the zoological survey and agricultural and forest entomology), and veterinary science. The programme of work proposed in each of these branches for the ensuing year is also published, and the report concludes with an account of the investigations for India, completed or in progress at the Imperial Institute during the year.

Agricultural Journal of India, 1908. **3.** Part 2. Introduction of improvements into Indian agriculture—The hand maize sheller—Sugar-cane borers of Behar (with plates)—Improvement of cotton in Bombay (giving an historical *résumé* of the efforts made to improve Indian cotton)—Sann hemp, Ambari and Agave, as fibre crops in the Central Provinces and Behar—Hairy caterpillars in Gujerat—Cultivation of cotton in India—Notes on ground nut-leaf disease—Egyptian cotton in Sind, etc.

Bulletin of the Agricultural Research Institute, Pusa. 1908. No. 9. Report on cocoanut palm disease in Travancore.

Memoirs of the Department of Agriculture in India. Botanical Series. 1908. Vol. II. No. 3. Toxic substance excreted by the roots of plants.

Forest Pamphlets. Chemical Series, No. 1. Note on the utilisation of Khair (*Acacia catechu*) forests in Eastern Bengal and Assam (gives the results of a chemical investigation of the wood of this tree from the Goalpara Division, showing that the opinion expressed by natives in this district that this wood cannot be used for making cutch is inaccurate). *Zoology Series, No.* 1. The bark-boring beetle attack in the Coniferous forests in the Simla catchment area (descriptions of the habits, life-histories, and damage done by the various beetles of this type are given). *Working Plan Series, No.* 1. A glossary of technical terms for use in Indian forestry.

Indian Forest Records, 1908, **1.** No. 2. A preliminary note on development of the Sal in volume and in money-value.

Progress Report of Forest Administration in Eastern Bengal and Assam, 1906–7.

Records of the Geological Survey of India, 1908, **36**. Part 3. Marine fossils in the Yenangyaung oilfield, Upper Burma—Occurrence of fresh-water shells of the genus Batissa in the Yenangyaung oilfield, Upper Burma—A new species of Dendrophyllia from the Upper Miocene of Burma—Structure and age of the Taungtha Hills, Myingyan district, Upper Burma—Fossils from the sedimentary rocks of Omam (Arabia)—Rubies in the Kachin Hills, Upper Burma—Cretaceous orbitoides of India—Two Calcutta earthquakes of 1906—Barytes occurring at Narravada, Nellore district—Tourmaline mines of Maingnin—Ammonites of the Bagh Beds.

Indian Trade Journal, 1908, **9**. June 18. World's cotton supply and consumption—Indian carpet industry—Economic developments in Bengal. 1908, **10**. July 2. Trade of Bunder Abbas—Manufactures and trade of Angul—Improvements of sericulture in Bengal—Egyptian cotton in Sind. 1908, **10**. July 9. Transport difficulties in Persia (gives information regarding the increase in cost of Indian articles imported into Persia owing to difficulties of transport). 1908, **10**. July 23. "Kashi" silk industry (a description of the silk-weaving industry introduced into Benares recently, in which silk yarn of Italian origin is used)—Assam coalfields (attention is directed to the offer of a lease for working the Umrileng coalfield). 1908, **10**. July 30. Burma's trade with Siam (enumerates the more important products of Siam and gives particulars of trade routes)—Behar indigo industry (historical)—French bauxite (describes this industry, which is of interest in view of the desire to develop the Indian bauxite deposits)—Industries of the native States of Pauna, Bijawar and Radhanpur. 1908, **10**. August 6. The camphor war (describes the competition between natural and synthetic camphor)—Plantain meal (a description of methods of making this product as tried in French Guiana). The various numbers of this Journal also contain, Indian crop forecasts, trade returns in some of the chief Indian products, calls for tenders, inquiries and lists of recent publications of special interest to India.

CEYLON.

Circulars and Agricultural Journal of the Royal Botanic Gardens, 1908, **4**. No. 9. Acclimatisation of plants (a *résumé* of work done in Ceylon, and giving a list of plants introduced into the island). No. 10. White ants (describes the habits of these tropical pests and suggests measures for their extermination). No. 11. Para rubber seed (an account of experiments on the germination of the seed).

Colonial Reports, Annual [Cd. 3729–25]. Gives the usual statistical information regarding planting operations and trade in rubber, cocoa, coffee, citronella oil, coconuts and coconut produce. Reference is also made to the more important results achieved during the year by the mineral survey carried on in the island in connection with the Imperial Institute.

Tropical Agriculturist, 1908, **31**. July. School gardens—Preparation of crude rubber—Cocoa as an adjunct to rubber culture—List of jungle products used by the poor during the famine, 1896–7—Differences between wild and cultivated plants—Manganese compounds as fertilisers—Review of the present conditions of the spirit industry in the Philippines—Arrowroot (describes the cultivation and preparation of this product)—Sugar industry of Formosa—West India citrate—Correspondence on various planting problems. A supplement (pp. 73–104) contains correspondence and notes on various products cultivated in Ceylon, with abstracts of articles from other journals dealing with these products. Of these reference may be made to the note on "Ceylon essential oils in 1907" and "Tea-planting in Java." The Journal also contains a large number of reprints from other publications.

STRAITS SETTLEMENTS AND FEDERATED MALAY STATES.

Agricultural Bulletin, 1908, **7**. July. Big rubber trees in the Botanic Gardens—Bee culture—Nutmeg cultivation in Singapore—A further use for the coconut—A plea for vegetable cultivation—A disease of cloves—Banana fibre—Another coconut beetle—Kabong sugar—Poisons excreted by plant roots—Planting in California—Para rubber trees in the Government garden at Tenom—Market reports, etc.

AUSTRALIA.

VICTORIA.

Journal of the Department of Agriculture, 1908, **6**. July 8. Hints on raising an export apple orchard—Effect of cold on new, dry wines—Selection of maize seed—Improvement of cereals by selection and crossing—Hemlock (an illustrated description of this, one of the proclaimed poisonous plants in the State, is given)—Pig-breeding in Victoria—Lucerne hay for fattening export mutton—Bamboo.

Fourth progress report on viticulture in Europe (deals with the Malaga district of Spain)—Review of the dairying season, 1907–8—The orchard (notes on points requiring attention during July)—Parasitic skin diseases of animals (one of a series of popular articles on animal diseases).

NEW SOUTH WALES.

Agricultural Gazette, 1908, **19**. June. A private experiment station for grasses (describing a farm near Singleton devoted to this purpose)—Cultivation of coffee (a general article on cultivation of coffee)—Wheat-growing in New South Wales—Beetles from the Solomon Islands attacking coconut palms (describing the life-histories of *Xylotrupes Gideon* and *X. Gideon* var. *oromedon*, and recommending spraying with tobacco and soap wash as a method of extermination).

QUEENSLAND.

Agricultural Journal, 1908, **21**. July. Utilising alkali patches (recommends mangolds and silver beet for cultivation in alkali soils)—Ground lime *versus* ground limestone—Prickly pear as food for stock (see p. 314)—Advantages and disadvantages of grading cream—So-called "African wonder grass"—Plants suitable for outdoor culture—School gardening in the Philippines—Cotton-growing (a description of the conditions obtaining in Queensland)—Prieto sisal-cleaning machine—Cassava (recommends this product for cultivation in Queensland)—Methods adopted for the eradication of cattle ticks in United States.

Government Mining Journal, 1908, **9**. June. Stanhills tinfields—Development, output, etc. of Queensland mines—Argentine mining industry—Rare metals and minerals and their uses (deals with the utilisation of uranium, vanadium, thoria, etc.)—Reports on Queensland mining-fields—Mining returns for Queensland, May 1908.

Department of Mines. Queensland Geological Survey. Publication, No. 198. Gold, platinum, tinstone and monazite in the beach sands of the south coast of Queensland. *Publication, No.* 203. Graphite in Queensland, with special reference to the Mount Bopple deposits. *Publication, No.* 204. Second report on the West Moreton (Ipswich) coalfield. *Publication, No.* 207. Mines in the Burnett district. *Publication, No.* 208. Report on the Norton goldfields.

WESTERN AUSTRALIA.

Journal of the Department of Agriculture, 1908, **16**. June. Experimental farms — Camel-breeding in Australia — Selecting seed potatoes—Experiments with grasses—Sheep-breeding—Cutting seed potatoes.

NEW ZEALAND.

Mines Record, 1908, **11**. February. Gold-mining in New Zealand—Gold-mining at Coromandel—Lignite beds of Central Otago.

Department of Agriculture. Bulletin, No. 5. *Division of Biology and Horticulture.* Bee culture (a monograph). *Bulletin, No.* 1. *Division of Live Stock and Agriculture.* Shelter-planting (describing the formation of shelter-belts for farms and orchards, and dealing particularly with the cultivation of wattles and eucalypts for this purpose). *Bulletin, No.* 12. *Division of Veterinary Science.* The sheep maggot.

SOUTH AFRICA.

CAPE OF GOOD HOPE.

Agricultural Journal, 1908, **32**. No. 6. South African bee-keeping—Lucerne, varieties, seed-bed, water measurement and cultivation—A report on work done at the Robertson Experiment Station—Experiments with ostriches (one of a series of articles on ostrich-breeding)—

Notes on co-operative wineries (giving an account of the working of these institutions recently established in the Colony)—American dry farming—Marsh mallow fibre—Underground waters of Cape Colony (a continuation of an article dealing with the composition of these waters). 1908, **33**. No. 1. Fusicladium disease of the pear and apple —Agricultural soils of Cape Colony (the first part of an article dealing with the composition and physical characters of the soils of the Colony)—South African bee-keeping—Report on grafted American resistant vines in the Robertson district—Bushes of the Karroo, and their feeding values as compared with cultivated crops (gives analyses of a number of bush plants)—Data required in choosing a windmill for irrigation purposes—Underground waters of Cape Colony (see note on previous issue)—Fodders and their nutrient values (records analyses of "vlei grass" and "ground maize cob" grown in the Colony)—Correspondence—Weather notes, etc.

Report of the Chief Conservator of Forests, including a report on railway sleeper plantations, for 1907.

NATAL.

Agricultural Journal, 1908, **11**. June. Cereals under irrigation. II. Milling qualities of Natal wheats—Early stripping of Natal wattle bark (pointing out that the industry in Natal is beginning to suffer through the export of immature bark (see this *Bulletin*, 1908, **6**. 157)—Cotton in Portuguese East Africa—Export of grain to Australia (gives information as to the market for maize and oats in Australia)—Report on the sheep disease known as "Blue tongue"—The place of legumes in our agricultural system—A new outlet for sweet potatoes (refers to the establishment of a factory in Natal for the extraction of starch from sweet potatoes)—Natal Agricultural Union (a continuation of the report on the proceedings of the Conference held in April last)—Progress report on horse-sickness—Sugar beets (giving analyses of sugar beets grown in the Colony)—Cultivation of sweet potatoes (gives results of manurial experiments carried on at Winkle Spruit Experimental Station) —Natal tea and its cultivation. III. Manufacture—Export of potatoes (a report on the recent experimental shipment of Natal potatoes to London)—Report on work done at the Winkle Spruit Experiment Farm, dealing especially with manurial experiments on maize. Each number also contains notes on agricultural conditions, market reports, correspondence, etc.

RHODESIA.

Agricultural Journal, 1908, **5**. No. 5. Rust-proof wheat (referring to a new rust-proof wheat evolved at Ficksburg, Orange River Colony, and now obtainable from the Agricultural Department of Rhodesia) —Tobacco notes, in which it is mentioned that the tobacco crop of this year in Rhodesia is estimated at 250,000 lb.

CANADA.

Annual Report of Topographical Survey Branch, Department of the Interior, for 1907.

Summary Report of the Mines Branch for 1907-8. This contains a summary of the field work done in British Columbia, Bathurst, New Brunswick, Megantic County, Quebec, and at Penetanguishene, Ontario, on iron-ore deposits. Mention is also made of the dispatch to Europe of an official to study the peat and lignite workings of Europe, with a view to the better development of these industries in Canada. The possibility of utilising Canadian peat for the manufacture of nitrates is also being investigated. Particulars are given of the Lash process of electrically smelting iron ores, as carried on at Niagara Falls. A preliminary report on the mining and metallurgical industries of Canada is published. An investigation of the coals of Canada was commenced at McGill University in 1906, and details of the test to be undertaken are now given.

THE WEST INDIES.

The recently issued Annual Reports on the botanic stations, etc. in the West Indies contain two new features, which render them of special interest. In the first place each contains some illustrations of scenes in the station itself or of some phase of agricultural activity in the island. The remote and comparatively little known Virgin Islands, for instance, are places of which photographs are not easy to obtain, and any one wishing to become acquainted with the local conditions will find the four views of the botanic station and neighbourhood, and those of the cotton factory, sugar works, and pineapple cultivation, of distinct service.

In addition, each report contains a historical account of the station and a short summary of what has been accomplished since the station has been under the control of the Imperial Department of Agriculture for the West Indies, *i. e.* since 1898 when Dr. (now Sir) Daniel Morris, K.C.M.G., was appointed Commissioner. A brief summary of the results achieved will serve to indicate the existing state of affairs in the islands, which differ markedly from one another in their natural conditions and potentialities.

Virgin Islands.—In this group of scattered islands, difficult of access, but poorly provided with means of inter-communication, and inhabited only by peasants, the Department commenced work in 1900. An old sugar estate was purchased and converted into an experiment station. Model plots of cocoa, coffee, limes and arrowroot were established as object lessons, and in addition good varieties of sugar-cane were distributed. Attention was devoted to cotton—formerly a principal crop, but abandoned after the temporary stimulus given by high prices during the American civil war—with such success that the exports of this product have risen from £35 in 1904 to £400 in 1907.

Montserrat.—The Presidency received a severe blow in the disastrous hurricane of 1899. Two years later three experiment stations were established, and amongst several other lines of work that on Sea Island cotton has proved of greatest material value. The first experiments, official and private, were made in 1901, and since 1904 the output has rapidly increased, going from approximately 63 bales (each of 500 lb.) of an average value of 1*s.* per lb. in 1903–4 to 320 bales of cotton worth 1*s.* 8*d.* per lb. in 1906–7. Cotton is now the staple industry occupying the lands near the sea, whilst sugar is still cultivated in the centre of the island. The cultivation of onions for export has also been initiated and is a small but well-established industry, whilst some 50,000 lime plants have been raised and distributed from the station. The Central American rubber tree (*Castilloa elastica*) and cocoa have been distributed and are likely to be successful in selected spots. Amongst other things efforts have been made to improve stock, and encouragement given to agricultural shows, school gardens, and to making the local products better known by exhibiting both in Canada and in Great Britain.

St. Kitts and *Nevis.*—The botanic stations in the two principal islands of this Presidency were established respectively in 1890 and 1903. The improvement of the sugar industry has been the chief line of work, and the elaborate experiments carried out have thrown important light on the manurial requirements of the cane. Amongst the new canes introduced the Barbados seedlings, B. 147 and B. 208, have proved the most successful. Although sugar is still the principal industry, cotton has been experimented with successfully, and in 1906 some 5,000 acres were under this crop. In addition to the material results, Dr. F. Watts, C.M.G., the Superintendent of Agriculture for the Leeward Islands, states, "Of more importance than all are the changes introduced insensibly in the members of the community generally. The work of the trained officers of the Department, and its constant, steady operation, has a wider and deeper influence than an uninterested observer may imagine. . . . There results a general progressive tendency, the origin of which cannot be readily or definitely traced, but which in its result on the community is perhaps of equal value or even greater importance than the conscious, definite efforts of the Department."

Antigua.—A botanic station was formed in 1889, but was transferred in 1894 to the existing site at St. John's. Sugar experiment stations and the Government stock farm also date from 1889. The condition of Antigua reached a low ebb during the period from 1895 to 1899, when, largely owing to the ravages of the "rind disease," the sugar industry was threatened with extinction. The sugar experiment station was then of great service in supplying the White Transparent cane, which is more disease resistant than the Bourbon, hitherto cultivated. Elaborate manurial experiments carried out during a long series of years have demonstrated that when the normal quantity of pen or farmyard manure has been applied, artificial manures, for at any rate the first

crop of canes, are superfluous. By the aid, too, of special Government grants two central factories have been established, and their usefulness has been amply demonstrated. The general result has been most gratifying, and it may safely be said that at no time during the last twenty years have the conditions of the sugar industry been more favourable.

Although sugar is, and appears likely to remain, the staple industry of Antigua, the development of the Sea Island cotton industry, dating from 1903, has been the most remarkable recent feature, and the export of cotton is now of the annual value of from £16,000 to £18,000 and likely to increase considerably. In comparison with the great changes effected in the sugar and cotton industries the other developments are small. The onion and lime industries have been fostered, and considerable attention given to the distribution of economic plants, the cultivation of a peasant's model garden, the improvement of stock, bee-keeping, agricultural education, including school gardens, and other useful lines of work.

Dominica.—The chief object of the Dominica Botanic Station, established in 1891, has been to raise and to distribute at moderate rates, plants of economic value. The annual output of such plants has fluctuated from time to time, but reached its maximum in 1906–7, when 83,000 were sent out. During the sixteen years since the garden was opened the total number of plants distributed is given as 697,000, no mean achievement considering the small staff (only one European), and that the stock sent out has included large numbers of budded citrus plants, grafted cocoa, nutmegs, mangoes, etc.; in 1906–7 some 2,300 such grafted and budded plants were distributed. In addition to supplying large numbers of the cocoa and lime plants, including the spineless variety of the latter, for the development of the two staple industries of Dominica, plants new to the island have been introduced, such as the Central American rubber (*Castilloa elastica*), Lagos silk rubber (*Funtumia elastica*), and Para rubber (*Hevea brasiliensis*), Sierra Leone coffee (*Coffea stenophylla*), Congo coffee (*Coffea robusta*), Alligator cacao (*Theobroma pentagona*), and various fruit trees and new varieties of pineapples and bananas.

Manurial experiments with cocoa have yielded results which have led to new methods being adopted on estates, and the model cocoa drier erected in 1901 proved so successful that nine driers of the same type are now in use on estates in the island. Agricultural education has received special attention, and at the Government agricultural school, opened in 1900, a total of thirty-two boys have passed through the thoroughly practical three years' course intended to equip them for the position of managers and overseers, and nineteen are now engaged in agricultural work in Dominica, and thirteen in Cuba, Trinidad and elsewhere. Encouragement and assistance to local agricultural shows, and to exhibitions abroad, are amongst the other directions in which work has been accomplished.

St. Lucia.—The botanical station at Castries dates from 1886, when the work of reclaiming the then swampy area now occupied by the garden was taken in hand. Plant distribution has been one of the chief services rendered by the garden, and between 1895 and 1907 over 260,000 plants, mainly limes, cocoa and rubber, have been sent out. New varieties of sugar-cane have been distributed to planters at low cost, and considerable attention has been devoted to experiment work to determine the best varieties for different soils and situations, and the most appropriate manurial treatment. Cocoa cultivation in St. Lucia is mainly in the hands of peasant proprietors, and useful lessons in methods of cultivation and treatment of diseases have been taught by the establishment of experiment plots of about one acre each situated by the side of main roads in the island. Agricultural education and improvement of farm stock have also been attended to, and on the whole, although no such striking changes are to be recorded as in some of the other islands, the efforts of the Department have been well employed in endeavouring to improve, under rather difficult circumstances, the general agricultural practice of the island.

St. Vincent.—The old botanic garden of St. Vincent dated from 1765, and was the first institution of its kind in the West Indies and possibly in the New World. The present garden, which dates from 1891, occupies a portion of the site of the old gardens abandoned in 1822. The St. Vincent garden is connected with at any rate one well-known historical event, the mutiny on the *Bounty*, under the command of Captain Bligh, occurring on the return voyage from the South Seas, where the ship had gone in 1790 to procure the breadfruit. Captain Bligh successfully accomplished the task in 1792, when the *Providence* was the means of bringing this valuable plant to St. Vincent, Jamaica and the Royal Gardens, Kew. St. Vincent suffered great damage in the hurricane of 1898, and still more recently during the eruption of the Soufrière in 1902. Both events were far-reaching in their effects on the agricultural industries of the island.

Sugar, formerly the staple crop, has been largely replaced by Sea Island cotton, the cultivation of which was experimentally started by the Department in 1903. Cotton (the Marie Galante variety) had always persisted as a crop in Carriacou, a small dependency of St. Vincent, but whereas in 1902 the export only amounted to £475, the value of the output of Sea Island and Marie Galante cotton in 1907 was over £28,000. Cocoa cultivation has been encouraged and assisted, 51,000 plants being distributed from the station during the last five years. Arrowroot was formerly so low in price as scarcely to be remunerative, but partly due to the increased attention given to cotton the acreage has declined, and it is hoped that prices will improve. The improvement of stock, the work at the agricultural school, and the free distribution of plants and instruction to allottees under the Land Settlement Scheme are other directions in which useful results have been achieved towards making St. Vincent once again a prosperous island.

Grenada.—During recent years cocoa has been the chief crop and has secured for Grenada a considerable measure of prosperity. The botanic station was founded in 1886, but, partly due to divided control between 1898 and 1904, did not contribute very largely to the general progress of the agricultural community. In the latter year it came definitely under the Imperial Department of Agriculture. Cocoa experiment plots were started in 1905, and with the agricultural instruction given are likely to prove beneficial to peasant proprietors. Spices, the second crop of Grenada, have received attention, and interest has also been directed to other plants, such as rubber, citrus fruits, cotton, etc. Efforts have also been made to improve the stock of the island.

GENERAL COLONIAL AND INDIAN PUBLICATIONS.

In the following paragraphs a summary is given of the more important contents of the chief Indian and Colonial periodical publications received recently at the Imperial Institute, in so far as these relate to economic products and are likely to be of general interest.

INDIA.

Indian Agriculturist, 1908, **33**. May. Oilseed crops of Bengal; final forecast—Roselle (*Hibiscus sabdariffa*) culture—Agriculture in Japan—Asafœtida—Pearling in Mergui—Manufactures and minerals of Bhandara—Comb-making in Japan—Indian manganese industry (from the *Madras Mail*)—New household loom—Deterioration of the coconut industry in Cochin—Steel industry for India—Forestry in Ceylon—Papaya seed cultivation in Ceylon—The white ant—Sugar in India—Tobacco-growing in India—Eri silk cocoons.

Indian Forester, 1908, **34**. No. 7. Physical effects of forests (a note on the proposed Indian Government inquiry on this subject)—Forest of the Terai and Bhabar Government estates in the United Provinces—Sandalwood at sea-level—Tikri forests, Gonda Division, U.P.

No 8. The plantations in the Bodyar First Class Forest, Jaunsar Division—Katha manufacture in the Gonda Division (a description of the manufacture of cutch as carried on in this district)—Instructions regarding the collection and identification of wood specimens—Utilisation of silt in Italy.

Each number also contains correspondence on forestry matters, notes on shikar, travel and natural history, etc., reviews of books, and notes on the timber and forest produce trade.

AUSTRALIAN COMMONWEALTH.

PAPUA.

Annual Report for Year ending June 30, 1907. Gives a description of the geological features of the island, its mineral wealth, gold

workings, and information regarding deposits of copper, lead, mercury, osmiridium, coal and other minerals. An account of the present position of agriculture is also given, reference being made to the proposal to experiment with Para rubber at the Kemp Welch and Milne Bay Nurseries.

WEST AFRICA.

Gold Coast.

Government Gazette, 1908, No. 65. Contains the Report on the Gold Coast Mines Surveys for 1907.

Colonial Reports, Annual: Ashanti [Cd. 3729-28]. Describes, *inter alia*, the progress made in recent years in encouraging the plantation of rubber, cocoa and other products by the natives. During 1907 nearly 100 tons of copal were collected in Obouassi, as against 44 tons in 1906.

Colonial Reports, Annual: Northern Territories [Cd. 3729-30]. Mentions the experiments made at Salaga and Yeji with "Volta River" and "American Black Rattler" cottons. Of these only the "Volta River" cotton planted at Yeji did well, and samples of this subsequently sent to the Imperial Institute were valued at $5\frac{1}{2}d.$ to $6d.$ per lb., with "Middling American" at $6{\cdot}4d.$ per lb.

Southern Nigeria.

Government Gazette, 1908. The Supplement to No. 45 contains the Annual Report on the Eastern Province for 1907.

The Supplement to No. 49 contains reprints of reports from the Imperial Institute on products from S. Nigeria, and an article on growing vegetables in the Protectorate.

ST. HELENA.

Colonial Reports, Annual [Cd. 3729-24]. Gives an account of the installation of the Government mill for the preparation of New Zealand flax, and mentions the export of a small consignment of Mauritius hemp, which is being grown experimentally. Reference is also made to the possibility of working the manganese and phosphate deposits which occur in the island, though the experts' reports on these deposits are not promising from this point of view.

BERMUDA.

Colonial Reports, Annual [Cd. 3729-32]. Records the success which has attended the efforts made to resuscitate fruit-growing in the island, and mentions the planting experiments undertaken recently with a view to ascertaining whether wrapper tobacco can be grown successfully.

FALKLAND ISLANDS.

Colonial Reports, Annual [Cd. 3729-26]. Gives data as to the exports of wool, tallow, sheep-skins, hides, seal-skins, etc., from which it appears that the exports of seal-skins for the years 1904-7 have been 103, 151, 325 and 3,472 respectively, as against 44,968 in 1903 (compare this *Bulletin*, p. 300).

LIBRARY.—RECENT ADDITIONS

Books, etc., exclusive of periodical Government Publications, presented to the Library of the Imperial Institute since May 15, 1908.

India.

Thacker's Indian Directory, 1907 . . (*The Secretary of State for India.*)

The Imperial Gazetteer of India. Vols. ii. and v. to xiv. (new edition) . . (*The Secretary of State for India.*)

History of the Rise, Progress, and Downfall of Buddhism in India . . . By Sumpa Khan-po Yeçe Pal Jor. (*The Bengal Secretariat Book Department.*)

Report of the Burma Chamber of Commerce for the year 1907 (with Appendices) . . . . . . (*The Secretary.*)

Report of the Committee of the Bengal Chamber of Commerce for the year 1907. Vol. i. . . . . . (*The Secretary.*)

Report of the Karachi Chamber of Commerce for the year 1907 . . . (*The Secretary.*)

Proceedings of the Madras Chamber of Commerce, 1907 . . . . (*The Secretary.*)

Report of the Bombay Chamber of Commerce, 1907 . . . . (*The Secretary.*)

"Gwalior, 1905." Narrative of the Official Visit of their Royal Highnesses the Prince and Princess of Wales to Gwalior . . . . . . By J. W. D. Johnston. (*H.H. the Maharajah Scindia.*)

The Fauna of British India, including Ceylon and Burma. Mollusca (Testacellidæ and Zonitidæ) . . .	By the late Dr. W. T. Blanford, F.R.S., and Lieut.-Col. H. H. Godwin-Austen, F.R.S. (*The Secretary of State for India.*)
The Fauna of British India, including Ceylon and Burma. Rhynchota. iv., Homoptera and Appendix (Pt.) . .	By W. L. Distant. (*The Secretary of State for India.*)
Calendar of the Calcutta University for the year 1908. Parts i., ii. and iii. . .	(*The Registrar.*)

Australia.

Annual Report of the Committee of the South Australian Chamber of Manufacturers (Incorporated), 1907 . .	(*The Secretary.*)
The South Australian School of Mines and Industries and Technological Museum, Annual Report, 1907; with Report on Opening Demonstration and Prospectus for 1908	(*The Secretary.*)
Catalogue of Minerals in the Technological Museum of the South Australian School of Mines and Industries, 1907 . .	(*The Secretary.*)
Fifty-eighth Annual Report of the Adelaide (South Australia) Chamber of Commerce (Incorporated), 1908 . .	(*The Secretary.*)
Annual Report of the Brisbane Chamber of Commerce (Incorporated), 1907–8	(*The Secretary.*)
Journal and Proceedings of the Royal Society of New South Wales, 1903–7	(*The Secretary.*)

New Zealand.

Forty-fourth Annual Report of the Wellington Chamber of Commerce, February 1908	(*The Secretary.*)
New Zealand University Calendar, 1908–9	(*The Registrar.*)

Canada.

Journal of the Mining Society of Nova Scotia. Vol. xi. Being the Transactions of the Society for the year 1906–7 .	(*The Secretary.*)
Modes of Occurrence of Canadian Graphite	By H. P. H. Brumell. (*The Author.*)

Canada in the Twentieth Century . .	(*The Commissioner of Emigration.*)
Annual Calendar for the Session 1908–9, with Examination Results for 1907–8 of the McGill University . . .	(*The Secretary and Bursar.*)
Rhodesia.	
Proceedings of the Rhodesian Scientific Association. Vol. vii., Part i., 1907 .	(*The Secretary.*)
Sixth Report of the Rhodesia Museum, 1907	(*The Director.*)
Natal.	
Natal Plants. Vol. v., Part iv. . .	Edited by J. Medley Wood, A.L.S.
West Africa.	
Atlas of West Africa, with Descriptive Letterpress	By J. A. Douglas. (*Messrs. W. & A. K. Johnston, Ltd.*)
Mauritius.	
Mauritius Almanac for 1908 . . .	(*The Colonial Secretary.*)
United Kingdom.	
Historical Geography of the British Colonies. Edited by C. P. Lucas, K.C.M.G. Vol. v., Canada; Part ii., Historical	By Hugh E. Egerton, M.A. (*The Delegates of the Clarendon Press.*)
Proceedings of the Royal Society of Edinburgh. Vol. xxviii., Parts iv., v. and vi.	(*The Secretary.*)
Transactions of the Royal Society of Edinburgh. Vol. xlv., Part iv.; and Vol. xlvi., Part i.	(*The Secretary.*)
Southport: Official Guide of the Corporation	(*The Town Clerk.*)
Annual Report of the Incorporated Chamber of Commerce, Liverpool, 1908	(*The Secretary.*)
City and Guilds of London Institute: Programme of Department of Technology for the Session 1908–9 . .	(*The Superintendent.*)
Proceedings of the Royal Colonial Institute. Vol. xxxix., 1907–8 . .	(*The Secretary.*)
Institute of Chartered Accountants in England and Wales: List of Members, Royal Charter and By-laws, 1908 .	(*The Secretary.*)

Calendar of the Imperial College of Science and Technology for the Session 1908–9 . . . . (*The Secretary.*)
Anglo-Russian Literary Society Proceedings, February, March and April 1908. (*The Secretary.*)

France.

Annales du Musée Colonial de Marseille. Vol. v., 2nd Series, 1907 . . . (*Musée Colonial.*)

Austria-Hungary.

La Société Nationale d'Agriculture de Hongrie, son Histoire et son Développement . . . . By Charles de Galgoczy.
Plantation et Culture des Saules Contre les Inondations . . . . . . By Eugene Vadas.
Hungary: A Sketch of the Country, its People and its Conditions . . . By Julius de Vargha.
La Viticulture en Hongrie . . . By Dr. François de Lonyay.
The State and Agriculture in Hungary . By Gyorgy.
Service des Stations Agronomiques Hongroises, 1900 . . . . .
Organisation du Personnel Employé dans le Service des Forêts Domaniales .
Loi XXXI de l'an 1879 sur les Forêts .
The International Convention for the Protection of Birds, 1902 . . . .
Some of the Answers and Papers presented to the International Agricultural Congress at Budapest, 1896 .
Instruction Relative aux Travaux de Revision Decennaux de la Gestion Forestière . . . .
Guide of the Party of English Agriculturists visiting Hungary in May–June 1902 (with Appendix) . . . .
L'Élevage de Chevaux en Hongrie . .
Historique de la Question des Expériences Forestières en Hongrie . . . .
The Economic Report Service in Hungary, 1908 . . . .
Petit Guide du Musée d'Agriculture Royal Hongrois . . . .
Lois les Plus Récentes de la Hongrie Relatives aux Ouvriers Agricoles . .
Agricultural Hungary . . .

Direction Nationale du Service des Eaux en Hongrie. Brochure iii., iv., v. and vii.	
Law XLV. of 1907. Juridical Relations between Employer and Farm Servant .	
Law XLVI. of 1907. State-aided Erection of Agricultural Labourers' Dwellings .	(*Dr. Tonelli.*)
Hungary : A Short Outline of its History.	By Louis Felberman.
Shakespeare in Hungary	By Professor Augustus Gyulai.
Alexander Petöfi	By Ilona Ginever.
Bibliography of English Authors' Works translated into the Hungarian Language (1620–1908)	Collected by Dr. Augustus Gyulai.
Education in Hungary	(*The President of the Educational Section, Hungarian Exhibition, Earl's Court.*)

Brazil.

Exploração do Rio Ribeira de Iguape .	(*Commissão Geographica e Geologica do Estado de S. Paulo.*)

Congo Free State.

Études sur la Flore du Bas et du Moyen-Congo	By É. D. Wildeman. (*Musée du Congo.*)

BULLETIN

OF THE

IMPERIAL INSTITUTE

1908. Vol. VI. No. 4.

SCIENTIFIC AND TECHNICAL DEPARTMENT.

RECENT INVESTIGATIONS.

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial and Indian Governments concerned.

SOME AFRICAN OILS AND OIL SEEDS.

During the last few years a large number of vegetable oils and oil seeds have been received for examination at the Imperial Institute from African Colonies and Protectorates. Some of these are new, and their characteristic constants have not been recorded previously. Others are from localities in which these oil seeds or oils are not at present produced in commercial quantities, and the results of their examination are mainly of interest in comparison with those of similar products already occurring in commerce. Reports on the results of examination of a number of African oil seeds have been published already in this *Bulletin*—notably "oil beans," derived from *Pentaclethra macrophylla*, from S. Nigeria (1907, 5. 10); "purging nuts," obtained from *Jatropha Curcas*, received from Lagos (1904, 2. 170); sesamé seed from Rhodesia (1907, 5. 184), and others which will be referred to in the course of this article.

There are considerable difficulties in the way of introducing new oil seeds into commerce because oil seed crushers as a rule confine their attention to a comparatively small number of kinds of seeds, obtainable in large supplies from well-recognised sources. Although, therefore, a new oil seed may be rich in oil and the latter may closely resemble one already used in the arts, it is essential that the oil seed should be available in large quantity, so that a regular supply of it can be maintained at a suitable price. It is therefore important in forwarding samples of new products of this kind for examination to supply at the same time data as to the quantities likely to be available. This question of the extent of the supply is less important in the case of seeds, such as sesamé, ground nuts, etc., which are already recognised articles of commerce; but even here it is not altogether negligible, since such seeds from new localities sometimes show peculiarities which introduce difficulties in working them by the usual processes, and which it is scarcely worth the manufacturer's while to devise means of obviating if the supply of material is uncertain.

To save repetition of explanations, it may be mentioned that the "acid" and "saponification" values in the following tables are expressed in milligrams of potassium hydroxide required for one gram of oil, the "Reichert-Meissl" values are given in cubic centimetres of decinormal potassium hydroxide required to neutralise the volatile acids from five grams of oil or fat, whilst the "Hehner" and "iodine" values and the "unsaponifiable matter" are expressed in percentages of the weight of oil or fat used. The "titer test" is the solidifying point, expressed in degrees Centigrade, of the mixed fatty acids. The specific gravities are taken at 15° C. for the oil and water except where otherwise stated. The yields of oil or fat are expressed in percentages by weight in the materials *as received.*

Most of the analyses have been made in the laboratories of the Scientific and Technical Department, but those marked ** have been made for the Imperial Institute by Dr. Lewkowitsch, and have been published by him elsewhere in greater detail, and references to these publications are given at the appropriate places.

Technical trials of a number of the oil seeds have been kindly

made for the Imperial Institute by firms of oil-seed crushers in this country, and of some of the oils by soap-manufacturers, varnish and paint makers and others; and the opinions quoted as to the commercial values of the oil seeds and oils are mostly based on the results of such trials.

The products dealt with fall naturally into three groups: (*a*) non-drying liquid or semi-liquid oils; (*b*) drying oils, represented by one product only, the oil from the kernels of *Ricinodendron Heudelotii*; and (*c*) solid or semi-solid fats. The first class of oils is employed industrially mainly in the manufacture of soaps, though those that are naturally nearly odourless and tasteless or can be refined to yield nearly odourless and tasteless products can also be employed in the preparation of edible materials, such as salad oils, cooking oils, etc. A typical commercial oil of this kind is cotton seed oil, of which the lower grades are used for soap-making, and the highly refined sorts for edible purposes. Roughly speaking, it may be said that the supply of cotton-seed oil rules the market for this type of oil in this country.

The second class of oils is employed in the manufacture of oil paints, oil varnishes, soft soaps, blown oils, rubber substitutes, etc. Perhaps the most important commercial oil of this class is linseed oil, and the price obtained for an oil of this type depends mainly on that ruling for linseed. In special cases, however, such as that of t'ung oil, which is particularly serviceable in certain industries, higher prices than those ruling for linseed oil are obtainable.

The uses of the class of solid or semi-solid vegetable fats are much the same as those of the group (*a*), the liquid non-drying oils, though for the former there is also a large demand in the candle industry. For industrial purposes these products, depending on their properties, are comparable in value mainly with the various sorts of palm, palm kernel, or coco-nut oils.

NON-DRYING OILS.

GROUND-NUT OIL FROM NORTHERN NIGERIA.

This was received in 1906. It was a cloudy, pale brownish-yellow oil, which became bright and lighter in colour on filtering. The oil had a slight unpleasant odour, suggesting that it had been over-heated in preparation. The colour and cloudiness of the sample showed that it had not been carefully prepared. Its constants were as follows :—

	Northern Nigeria oil.	*Commercial oil.*
Specific gravity . . .	0·916	0·911 to 0·920
Acid value . . .	1·2	—
Saponification value . .	187·0	185·6 to 197
Iodine value . . .	83·6	83·3 to 103

The sample possessed the usual characters of ground-nut oil, but on account of its slight peculiar odour and taste it would only be suitable for soap-making. Ground-nut oil is at present quoted in the London market at £38 to £45 per ton, depending on its quality.

At present, supplies of ground nuts are mainly derived from Senegal, Gambia, Madagascar and India, but the plant is widely grown for the sake of its seeds, and large quantities are produced for example in the United States, for local consumption.

Reference has been made already in this *Bulletin* (1906, **4**. 97) to ground-nut oil from Rhodesia, where some attention has been paid in recent years to this crop.

"IKPAN" SEEDS FROM SOUTHERN NIGERIA.

A short account of the oil obtained from these seeds has been given already in this *Bulletin* (1907, **5**. 132), and the results now published are of interest mainly for comparison with those yielded by the previous sample. It is possible that these may be the seeds of one of the forms of water-melon (*Citrullus vulgaris*) common in W. Africa, and the constants of the oil agree with this supposition.

The seeds resembled the previous sample, but were unshelled, and consisted of 36 per cent. shells, or husks, and 64 per cent.

kernels. The latter yielded 40·6 per cent. of oil, equivalent to 25·4 per cent. on the entire seeds, which is practically identical with the previous result.

The oil was clear and pale yellow in colour, and deposited a small amount of white flocculent matter on standing.

	Oil from present sample.	Oil from previous sample.	Water-melon seed oil.
Specific gravity . .	0·922	0·9184	—
Acid value . . .	1·4	5·5	—
Saponification value .	196·5	194·0	193·3
Iodine value . . .	107	106	101·5

As stated previously, the value of the oil in Europe for soap-making would be about £1 per ton less than that of cotton-seed oil, *i. e.* from £22 10*s.* to £24 at the present time, but it is possible that the oil would be suitable for edible purposes, in which case it would be of higher value.

It seems unlikely that commercial consignments of these seeds could be procured at present in Southern Nigeria for export, since it is stated by the Forest Officer for the Eastern Province that there is a large local demand for them as food at higher prices than they would realise in this country.

"INOY" KERNEL OIL FROM SOUTHERN NIGERIA.

In a previous number of this *Bulletin* (1906, **4.** 200) a description was given of Inoy kernels and the oil obtained from them. Since then further samples of the kernels, and of the oil prepared by natives in Southern Nigeria, have been received and examined. In addition analyses of the kernels and oil have been made in this country by Edie and in Germany by Brieger and Krause. The latter authors obtained their material from the Cameroons, where the tree (*Poga oleosa*) is known as "Njore-Njole." (*Tropenpflanzer*, 1908, **12.** 83.) It is of interest therefore to bring these various results together, since they serve to show the extent to which the oil content of the kernels and the usual "constants" of the oil vary. The oil is pale yellow in colour, and deposits a small amount of solid matter on standing.

	Analyses made at the Imperial Institute.			*Analysis made by Edie.*	*Analysis made by Brieger and Krause.*
	Kernels.		Native prepared oil.		
	No. 1.	No. 2.			
Specific gravity . . .	0·896	0·914	0·918	0·9091*	0·9135†
Acid value	39·7	45·3	—	56·0	—
Saponification value . .	184·49	192·9	184·05	188·0	193·05
Iodine value	89·7	90·9	85·35	93·0	93·3
Hehner value	93·0	94·5	—	—	—
Reichert-Meissl value .	1·45	—	—	—	0·66
Titer test	22°	24·5°	—	—	—
Percentage of oil from kernels	60·8	—	—	57·4	62

* Determined at 20° C. and compared with water at 4° C.
† Temperature not stated.

"BEN" SEEDS FROM NORTHERN NIGERIA.

A full account of ben seeds and ben oil has been given already in this *Bulletin* (1904, **2.** 117); and in a "Report on a Series of Mineral and Vegetable Products from Northern Nigeria" (Colonial Reports—Miscellaneous No. 26 [Cd. 1939]), further reference was made to the seeds, of which a small sample from the Borgu Province of Northern Nigeria had been examined. A further supply of about 50 lb. was received from Northern Nigeria in 1906.

The seeds had not been thoroughly dried before packing, and on arrival they were somewhat mouldy. To prevent further fermentation they were dried by hot air.

The greater portion of the sample was sent to a firm of oil pressers, who obtained from the cleaned seed 21·14 per cent. of "cold pressed oil," and, on further expression at a temperature of 60° C., an additional 6·6 per cent. of "hot pressed" oil, equal to a total yield of 27·7 per cent. of oil. Both oils were dark coloured. The previous sample from Northern Nigeria yielded 38 per cent. of oil by extraction with solvents.

The following table gives the constants obtained in the examination of the hot and cold pressed oils, and also, for comparison, the same constants for other samples from Jamaica and Northern Nigeria previously examined at the Imperial Institute (see this *Bulletin*, 1904, **2.** 117).

	Present samples.		Other results for comparison.			
	Crude cold-pressed oil from Northern Nigeria.	Crude hot-pressed oil from Northern Nigeria.	Liquid* oil from Northern Nigeria.	Solid* oil from Northern Nigeria.	Liquid* oil from Jamaica.	Solid* oil from Jamaica.
Specific gravity	0·9018	0·8984	0·914	—	0·912	0·865†
Acid value	49·71	100·50	15·3	—	8·7	7·2
Saponification value	179·20	178·70	189·2	194·4	196·3	193·6
Unsaponifiable matter	1·67	2·69	—	—	—	—
Iodine value	100·30	88·00	70·7	68·3	70·1	65·2

* The oil extracted from the seeds by solvents, such as ether, separates on standing into solid and liquid portions, and these were examined separately.

† Specific gravity at 100° C.

The high acidity of the samples of the crude oils shows that they are very rancid, due probably to partial decomposition of the seed from which the oils were expressed. The oil, as represented by the present samples, would have to be refined before it could be utilised for any purpose other than soap-making.

An average sample of the hot-pressed cake was ground to powder and examined. Indications of the presence of an alkaloid were obtained, but the quantity of material available was insufficient to permit of the isolation of the alkaloid, or the determination of its nature.

The following figures show the composition of the cake, as compared with that of a cake (containing the same percentage of oil) obtained from a sample of ben seed from Jamaica, and of cotton seed cake, which is largely used for cattle food :—

	Ben seed.		Average cotton seed cake.
	Hot-pressed cake, Northern Nigeria.	Cake from Jamaica seed.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	5·96	7·15	8·5
Albuminoids	24·12 }	21·51 }	43·5
Other nitrogenous substances	34·81 }	24·56 }	
Fat	11·27	11·27	13·5
Fibre	4·32	—	5·4
Ash	5·66	4·98	7·0
Other non-nitrogenous substances	13·86	—	—

The cake is remarkable for the high percentage (9·43) of nitrogen which it contains, and also for the large proportion of this which is present in the non-albuminoid state

and which therefore cannot be considered as of nutritive value.

The possible presence of an alkaloid and the large amount of non-albuminoid nitrogenous matter, pointed to the necessity for careful feeding trials before the product could be recommended as a cattle food. Some experiments made in this direction showed that neither cattle nor sheep would eat the cake, most probably on account of its unpleasant taste, which may have been due in this instance to the mouldiness of the seeds from which the cake was prepared.

The high percentage of nitrogen indicates that the cake might be utilised as a manure, since it is richer in nitrogen than rape cake, which is largely used in this way.

CARAPA SEEDS.

Oil seeds from several species of carapa have been received at the Imperial Institute for examination. As there appears to be a good deal of confusion in the technical literature regarding the botanical origin of the various carapa seeds and oils, which have appeared in commerce from time to time or have been investigated by chemists, it will be convenient to summarise here the distribution of the various oil-seed yielding carapa species and their synonymy. For the latter purpose De Candolle's monograph on the order Meliaceæ, in which the genus is placed, is taken as the authority.

Carapa procera, D.C. = *C. Toloucouma*, Guillet Pers; *C. guineensis*, Juss; *C. guyanensis*, Oliv. This occurs in the Antilles, Guiana, Senegambia and tropical Africa.

Carapa guianensis, Aubl. = that of Oliver's Flora of Tropical Africa, *pro parte*. This is found in Guiana, Martinique, San Domingo, Guadeloupe, Venezuela and Brazil.

Carapa moluccensis, Lam. Occurs in East Africa, Seychelles, etc.

Carapa grandiflora, Dawe and Sprague. Occurs in East Africa and Uganda.

Sample from Sierra Leone.—The consignment, described as *Carapa guyanensis* (*C. procera*, D.C., see note above), consisted

of characteristic roughly tetrahedral seeds, each having a rather rough reddish-brown shell enclosing a single kernel covered with a pale-brown papery skin. When fresh the kernels appear to nearly fill the shells, but in this consignment most of them had dried and shrunk, assuming irregular shapes. The consignment contained about 35 per cent. of good kernels, 27 per cent. of bad kernels, and 37 per cent. of shells.

The good kernels yielded about 57 per cent. of oil by extraction with solvents, and 46·7 per cent. by expression, 24 per cent. being obtained in the cold and 22 per cent. on heating and further expression.

The "cold pressed" and "hot pressed" oils presented much the same appearance, being viscous dirty-brown liquids, and possessing a slight characteristic odour, and extremely bitter taste.

	Cold-pressed oil.**	Hot-pressed oil.**
Specific gravity 40° C.	0·9179	0·9174
" " 15° C.	0·9272	0·9327
Saponification value	197·1	196·4
Iodine value	75·6	71·2
Reichert-Meissl value	3·5	3·1
Unsaponifiable matter	1·5	2·0
Titer test	35·4°	36·1°

A portion of the "hot pressed cake" obtained in the technical trials referred to above was analysed, and gave the following results:—

	Per cent.	*The ash contains:—*		Per cent.*
Moisture	9·8	Potash	K_2O	1·91
Ash	5·9	Lime	CaO	0·18
Nitrogen	2·9	Phosphoric acid	P_2O_5	0·51

* Calculated on the cake.

These results indicate that the carapa cake would be of rather low manurial value as compared with castor seed cake, rape seed cake, cotton seed cake, and similar materials used as manures and would perhaps be worth about £2 per ton.

Sample from the Gold Coast.—A supply of these seeds, referred to *Carapa guineensis* (*C. procera*, D. C., see note above), was received early in 1907.

They were irregularly tetrahedral in shape and had a brittle husk, which could be easily separated. The kernels were white and spongy, and had an intensely bitter taste. The husks constituted 25·7 per cent. by weight of the seeds. The yield of oil was 49·3 per cent. from the kernels, equivalent to 36·6 per cent. on the whole seeds.

The oil was pale yellow and had a bitter taste; on standing, it partially solidified to a white mass. It is not readily extracted from the seeds by light petroleum. The oil had the following constants ** :—

Specific gravity	0·917
Acid number	5·4
Saponification number	196·9
Iodine value	65·7
Hehner value	93·1
Titer test	36·0

Sample from Uganda.—This consisted of the seeds of *C. grandiflora*, and was forwarded for examination by the Officer-in-Charge of the Scientific and Forestry Department at Entebbe in September, 1907.

The nuts were larger than those of *C. procera*, but resembled them in shape and appearance. The kernels were moist, soft and fleshy, and consequently contained much less oil than those of an earlier sample from Uganda, which were dry and shrivelled. A fair proportion of the kernels was bad, and these were not used in the investigation.

On extraction with solvents the kernels furnished 30·2 per cent. of oil, compared with 52 per cent. from the dry kernels of a previous consignment. The kernels were also submitted to technical trials, and it was found that on cold expression, using a pressure of 150 atmospheres, they furnished 10 per cent. of a pale-yellow oil, which deposited a small amount of solid matter on standing. On further expression, at a temperature of 150° F., a quantity of darker-coloured semi-solid oil was obtained. Both oils were intensely bitter.

The chemical examination gave the following results ** :—

** A more detailed account of the chemistry of this and the other Carapa oils is given by Dr. Lewkowitsch in the *Analyst* (1908, **33**. 185; 1909, **34**).

	Cold-pressed oil.	Hot-pressed oil.
Specific gravity	0·9261	0·9306
Saponification value. . .	198·1	201·8
Iodine value, per cent. . .	83·7	72·6
Unsaponifiable matter, per cent.	3·75	1·59
Titer test	34·9	38·9

The residual cake is very bitter, and only suitable for use as manure. It contains the following percentages of constituents of manurial value: nitrogen, 2·07; potash, 1·18; phosphoric anhydride, 0·603; and lime 0·296.

Comparison of Carapa Oils.—In view of the fact that the oils now dealt with came from two different species and three different localities, it is of interest to give in one table the results obtained with them, and to add figures for a sample of oil from seeds of *Carapa guianensis*, Aubl., from Trinidad, previously examined. (See *Technical Reports*, published by the Imperial Institute, 1903, p. 135.)

Source of oil.	Country of origin.	Specific gravity.	Acid value.	Saponification value.	Iodine value.	Hehner value.	Titer test.
C. procera . . .	Gold Coast . . .	0·917	5·4	196·9	65·7	93·1	36·0
,, . . .	Sierra Leone .	0·927*	—	197·1	75·6	—	35·4
		0·932†	—	196·4	71·2	—	36·1
C. grandiflora . .	Uganda . . .	0·9261*	—	198·1	83·7	—	34·9
		0·9306†	—	201·8	72·6	—	38·9
C. guianensis . .	Trinidad	0·9225	—	195·6	65·0	93·7	—

* Cold-pressed oil. † Hot-pressed oil.

It will be seen that the oils exhibit a close general resemblance, and it would appear likely that the composition of the oils derived from the three species differs but little. It is also remarkable that the seeds of all three species are very bitter. This bitterness appears to be due to a resinous substance soluble in alcohol.

Commercial Value.—The technical expert who carried out trials with all three samples of carapa seeds from Sierra Leone, Gold Coast, and Uganda, valued the oil at about £20 10*s.* per ton, and stated that as the residual cakes were very bitter they could not be used for feeding purposes. As the analyses given above show that these cakes are also of low manurial value it is probable they would not be worth more than £2

per ton. The value of the *kernels* would depend on their richness in oil. Of the samples now dealt with, one yielded only 30 per cent. and others over 50. The oil content can be considerably enhanced by drying the kernels thoroughly in the sun before shipment, and this will also render them less liable to become mouldy during transit. It should be understood that the nuts should be decorticated before shipment, as the kernels only would be readily saleable here.

Calodendron capense oil.

A specimen of this oil was received at the Imperial Institute from British East Africa in 1904. The tree yielding the seed occurs rather sparsely in East Africa, and is sometimes grown there and in South Africa as an ornamental plant. It does not occur, so far as is known, in sufficient quantity to be a commercial source of oil, so that it is merely a matter of general interest to record the characters of the oil. The latter is pale yellow in colour with a slight rather pleasant odour and a somewhat bitter taste. It deposits a small amount of solid matter on standing. On examination it gave the following constants:—

Specific gravity	0·9190
Acid value	27·0
Saponification value	192·0
Iodine value	98·4
Unsaponifiable matter	2·1
Titer test	35°

These results indicate that the oil is of a non-drying type and would be suitable for soap-making, but, as there is at present no prospect of it being obtained in quantity, its commercial value need not be discussed.

BALANITES ÆGYPTIACA OIL.

The fruits, kernels and oil derived from the latter have been received from Northern Nigeria, the Anglo-Egyptian Sudan, and Uganda:—

Samples from Northern Nigeria.—(*a*) *Oil.* This was labelled "Betu oil" from seeds of *Balanites ægyptiaca.* It was cloudy, of

bright yellow colour, and possessed a somewhat unpleasant smell. A quantity of dirty greenish-brown sediment was present at the bottom of the bottle containing the oil. After filtration the oil was quite clear, but a white flocculent substance was deposited on standing.

(*b*) *Kernels.* These were about ½ inch long, pointed at one end, and about ¼ inch thick; they were light brown, semi-transparent, rather hard, and had a rancid bitter taste. The kernels yielded 58·7 per cent. of oil.

Sample from the Sudan.—This consisted of the fruits, called in the Sudan "Heglig seeds." They were oval in shape, and had a thin, wax-like outer skin, covering a layer of half-dried, sticky pulp of unpleasant odour; inside this was a hard, thick, fibrous shell, containing the pale yellow, oil-yielding kernel. The yield of oil was 41 per cent. on the weight of kernels, equivalent to 3·6 per cent. on the whole fruit. The oil as extracted from the kernels by solvents was pale yellow and transparent, possessed no marked odour or taste, and showed no tendency to dry after being exposed to the air on a glass plate for several days.

On analysis these oils gave the following results:—

	Balanites oil from Northern Nigeria.	*Balanites oil extracted from the Sudan fruits.*
Specific gravity	0·919	0·9187
Acid value	5·0	1·4
Saponification value	196·7	194·2
Iodine value	92·5	98·2
Hehner value	95·2	98·6
Reichert-Meissl value	—	trace
Unsaponifiable matter, per cent.	0·6 (approx.)	—
Titer test	34·6° (approx.)	34°
Percentage of oil in kernels	58·7	41

The oil consists of a mixture of glycerides of the following acids: oleic, 33 per cent.; linolic, 33 per cent.; stearic and palmitic, about 34 per cent.

Sample of Oil from Uganda.—This was received early in 1907 with the information that it was considered by the natives in certain parts of the Protectorate, a specific for sleeping

sickness, and that it was used in some parts of the Sudan as a purgative. It was asked that experiments might be conducted with the oil, in order to ascertain whether it had any therapeutic value. Prof. Cushny, F.R.S., kindly undertook to make these trials with (*a*) oil extracted from the kernels at the Imperial Institute, and (*b*) oil as prepared in the Nile Province of Uganda. Prof. Cushny's results show that the oil is of no value in the treatment of sleeping sickness, and that although the native prepared oil, which was dark-coloured and dirty, exerted an aperient action, this was very slight and not likely to render it of any value in European medicine.

Commercial Value of the Oil and Kernels.

The results of the examination show that the oil of *Balanites ægyptiaca* closely resembles cotton-seed oil in chemical characters, and, like the latter, it could no doubt be utilised in soap-making. Its colour and taste would prevent its use for edible purposes.

Samples of the kernels have been submitted for commercial trial and valuation to a firm of soap-makers, who report that the oil would be worth about as much as refined cotton-seed oil, the present value of which is £23 10*s*. to £25 per ton.

It is difficult to give even an approximate valuation for the kernels, since much depends on whether the "cake" left after the expression of the oil is suitable for use as a feeding material.

It is a question for local decision whether it would pay to extract the kernels, which alone are of commercial value, from the fruits for export, as the removal of the pulp and fibrous shell is likely to be a troublesome process.

"ZAWA" OIL, FROM THE SUDAN.

In a previous number of this *Bulletin* (1908, **6**. 243) an account was given of the results of the examination of a number of samples of the seeds of *Lophira alata* from Sierra Leone, where the oil is known as "Niam" fat or "Meni" oil. This tree also occurs in the Sudan, and oil prepared there from the seeds has been received for examination. The product is known in the Sudan as Zawa oil.

The sample measured one pint, and consisted of a dark orange-brown oil, containing a little sediment, and possessing

an unpleasant taste. The chemical examination of the oil gave the following results, for comparison with which the figures obtained in the laboratories of the Gordon College, Khartoum, for another sample of Zawa oil, and those furnished by oils extracted from seeds of *Lophira alata* sent to the Imperial Institute from Sierra Leone are added:

	Sudan Sample sent to Imperial Institute.**	*Sudan Sample* examined at Gordon College Laboratories.	*Sierra Leone Samples.***
Specific gravity at 40°/40° C.	0·9063	0·8615*	0·9016 to 0·9105
Acid value	5·78	—	18·54 to 48·0
Saponification value	190·10	177·1	180·7 to 195·6
Unsaponifiable matter	1·38	—	0·5 to 1·49
Iodine value	78·72	72·7	68·4 to 72·5
Titer test	42·5°	—	47·0 to 49·0

* Specific gravity at 100° C. (water at 15° C. = 1).
** The Sudan sample, as also one of the Sierra Leone samples, was examined for the Imperial Institute by Dr. Lewkowitsch, and is described in the *Journ. Soc. Chem. Ind.*, 1907.

The oils extracted from the Sierra Leone seeds at the Imperial Institute were almost white or pale yellow and semi-solid, whereas the oil received from the Sudan was much darker in colour and liquid, though it deposited a good deal of solid matter on standing.

The Sudan oil had an unpleasant taste, but Dr. Beam of the Gordon College laboratories records that the oil he examined had an agreeable flavour, somewhat recalling that of arachis oil. All the oils prepared at the Imperial Institute from seeds received from Sierra Leone had a slight unpleasant taste, and the residual cake was bitter.

The commercial values of the kernels of *Lophira alata* and of the oil they yield were dealt with in the previous article (*loc. cit.*).

DRYING OIL.

Ricinodendron Heudelotii (*R. Africanum*) *Seeds.*

Reference has been made already in this *Bulletin* to "Nsa-sana" seeds from Southern Nigeria, the kernels of which were found to yield 45·2 per cent. of a drying oil (1907, **6**. 369). As the first supply received was very small, a request for a small consignment was sent to S. Nigeria, and in response thereto the material now dealt with was supplied.

It consisted of small rounded nuts, dirty brownish-grey in colour. The shells were very hard and thick, and possessed a bright white internal coating. The kernels, which were white and soft and could not be freed easily from the shells, formed 29 per cent. and the shells 71 per cent., by weight, of the whole seeds. The material received previously consisted of kernels only.

The yield of oil was 47·0 per cent. on the kernels, or 14 per cent. on the entire nuts. It was light yellow in colour, with a pleasant taste resembling that of ground-nut oil, and dried to a film in a few hours. It gave the following results on examination:—

	Oil from *Ricinodendron Heudelotii* seeds.	Oil from Nsa-sana seeds received previously.
Specific gravity . .	0·9347	0·932
Acid value . . .	1·2	—
Saponification value .	184·7	191·6
Iodine value . .	148·2	147·7
Hehner value . .	94·1	95·2
Reichert-Meissl value .	1·9	—
Unsaponifiable matter .	1·2	—
Titer test . . .	34·5°	35·7°

Commercial Value.

The results of the chemical examination show that the oil from the Ricinodendron seeds closely resembles that previously obtained from the Nsa-sana seeds.

A large sample of the seeds was submitted to a firm of varnish manufacturers, who, after conducting experiments with the oil, reported that in their opinion it would prove a welcome addition to the list of oils useful to the varnish maker. They stated that the oil from the Ricinodendron seeds stands intermediate in properties between t'ung oil and linseed oil, and would be superior to the latter for many purposes. They further stated that if this oil could be produced cheaply on a commercial scale it would compete with t'ung oil.

Large quantities of these nuts are stated to be available in certain districts of Southern Nigeria, but it seems doubtful

whether they could be exported profitably from West Africa, for the following reasons :—

1. The low proportion of kernel in the nut, and the great difficulty of separating the kernels.

2. The low yield of oil from the entire nuts (14 per cent.).

3. The cake is of no value except as a manure.

4. Regarding the oil as equal in value to t'ung oil (£30 per ton), the market price of the unshelled seeds would not exceed £4 10*s.* per ton in this country, which according to the figures given by the Forest Officer at Benin would probably not pay for the cost of collection.

If, however, means could be found of freeing the kernels from the shells in order to reduce the cost of transport, there is little doubt that the kernels would find a ready sale in this country, and that the oil would be at least as valuable as linseed oil, which is at present worth £21 12*s.* 6*d.* to £21 17*s.* 6*d.* per ton.

SOLID OR SEMI-SOLID FATS.

"SHEA" NUTS AND BUTTER.

A considerable amount of attention has been given to "Shea butter" in recent years as a raw material for the manufacture of soap and candles, and also for the production of edible fats; and, as a result, interest in the possibility of increasing trade in this product has been aroused, particularly in West Africa, whence the commercial supply of the "nuts" and butter is derived at present. The specimens of these products now dealt with have been received from the Governments of Northern and Southern Nigeria, the Gold Coast, and the Sudan, and in part from the Royal Niger Company.

Samples from Southern Nigeria.

Shea Butter.—This consisted of two packages of Shea butter, each weighing about 21 lb. The butter was soft, of pale greenish-yellow colour, and possessed a slight characteristic odour.

Shea Nuts.—Two samples were received in October, 1905.

(1) One of these was labelled "Tengba," and consisted of 50 lb. of small, nearly black, seed-kernels many of which were pierced by insects.

(2) The second was labelled "Bomo," and consisted of 50 lb. of small dark-brown kernels.

(3) A third sample consisted of large kernels, which varied in colour from light to dark brown. Many of the kernels had been attacked by insects.

(4) A fourth was described as "kiln-dried Shea nuts," and consisted of small light-brown kernels, only a few of which had been attacked by insects. The last two samples represented the material as usually imported into this country.

The percentages of fat in the four samples of kernels were determined by extraction with light petroleum, with the following results :—

No. of Sample.	Percentage of fat in the kernels.
1	54·5
2	48·0
3	41·4
4	46·2

It will be observed from these figures that the amount of fat present in the nuts shows considerable variation, ranging from 41·4 to 54·5 per cent. The "Tengba" nuts (No. 1) contained the highest percentage of fat.

The sample of Shea butter forwarded from Lagos, and the fats extracted from samples of nuts Nos. 3 and 4 referred to above, were examined chemically. It was thought that a comparison of the two latter specimens would indicate whether the kiln-drying had affected the chemical composition of the fat. The results are given in the following table, to which have been added for comparison the figures furnished by a sample of Shea butter from the Gold Coast.

	Shea butter from Lagos.	Shea butter from Gold Coast.	Fat from untreated kernels No. 3.	Fat from kiln-dried nuts No. 4.
Specific gravity at $\frac{100^\circ C.}{15{\cdot}5^\circ C.}$	0·862	—	—	—
Acid value	18·0	10·3	33·9	26·2
Saponification value	179·0	181·7	181·2	180·2
Iodine value	58·7	54·0	59·4	55·8
Hehner value	96·5	—	—	—
Unsaponifiable matter	1·7	—	—	—
Titer test	52·0°	53·2°	—	—

It will be seen that these results are in general agreement, the only considerable difference being in the acid values.

A comparison of the figures for the fats extracted here, shows that the kiln-dried kernels contain a higher percentage of free fatty acids than the other specimens.

Samples from Northern Nigeria.

Early in the present year two specimens of nuts, labelled "Giddauchi" and "Eko" respectively, were received from Northern Nigeria. These were identified at Kew as seeds of "forms" of *Butyrospermum Parkii* (the Shea butter tree). The seeds presented considerable difference in size, the "Eko" sort ranging from 1·5 to 2·5 inches in length, whilst the "Giddauchi" variety was about 1·4 inches long on the average. These differences are of some interest in view of Chevalier's recognition (see this *Bulletin*, p. 449) of several varieties of the Shea butter tree. The results of the examination of the two kinds are as follows:—

	Giddauchi nuts.	Eko nuts.	Native prepared Shea butter from Lagos.
Kernels: yield of fat	48·6	52·4	—
Fat: Specific gravity at $\frac{99^\circ \text{C.}}{15^\circ \text{C.}}$.	0·8691	0·8671	0·862
Acid value	7·6	18·2	18·0
Saponification value . .	181·5	182·8	179·0
Iodine value	62·0	57·7	58·7
Hehner value	91·2	94·6	96·5
Reichert-Meissl value . .	2·6	1·84	—
Unsaponifiable matter .	6·3	7·0	1·7

The principal difference to be noted is in the higher proportion of unsaponifiable matter in the fats from these kernels received direct from Northern Nigeria than in those obtained from kernels as imported from S. Nigeria and in the native prepared Shea butter. It is stated, however, that in commerce samples of Shea butter and Shea oil (the product expressed from the kernels in Europe) as much as 10 per cent. of unsaponifiable matter sometimes occurs. . . . . .

Samples from the Sudan.

In the Sudan the nuts and butter are known as "Lulu" nuts and oil respectively.

Lulu Nuts.—These were smaller and rounder than those received from Nigeria, but otherwise were similar in appearance. The proportion of shell to kernel was approximately as 1 : 2.

The kernels yielded 47·2 per cent. of very pale yellow fat, as compared with 46·4 to 52·4 per cent. of fat obtained from the Nigerian samples. On examination this gave the following results:—

Specific Gravity at $\frac{99^\circ \text{ C.}}{15^\circ \text{ C.}}$	0·8594
Saponification value	184·0
Iodine value	62·9
Hehner value	91·9
Reichert-Meissl value	1·4
Unsaponifiable matter	4·3

Lulu Oil.—This consisted of the solid fat, which had a dull, greyish colour, quite different from the pale yellow colour of the West African product. On melting and filtering, a considerable quantity of suspended matter was found to be present, but the filtered "butter" still retained its original colour, and appeared to be rather softer than the samples of "shea butter" from West Africa, which have been examined at the Imperial Institute. From the appearance and smell of the specimen it seemed possible that the fat had been overheated in the process of extraction from the seeds.

The fat was submitted to chemical examination, and the results obtained are given in the following table, together with the figures furnished by a sample of native prepared "shea butter" from Lagos:—

	Present sample from the Bahr-el-Ghazal.	Sample from Lagos.
Acid value	10·7	18·0
Saponification value	184·6	179·0
Iodine value	56·0	58·7
Titer test	51·8°	52°

The "constants" found for this sample of "Lulu oil" from the Bahr-el-Ghazal are in general agreement with those obtained at the Imperial Institute for samples of Shea butter from other sources, and also with the results recorded by Dr. Beam for two other Sudanese specimens.

The dull greyish colour of this sample of "Lulu oil" from the Sudan might possibly create a prejudice against it, but this defect could probably be easily overcome by more careful preparation.

Commercial Valuation of Shea butter Samples.

Shea butter is used in the manufacture of candles, and also to some extent in soap-making, although the large amount of unsaponifiable matter, which it sometimes contains, is said to render it unsatisfactory for the latter purpose. The high percentage of free fatty acids renders the fat unsuitable for lubricating purposes.

Refined Shea butter is said to have been employed recently, especially on the Continent, for use in the manufacture of butter substitutes, and for other edible products, but it is difficult to obtain definite information on this point. An analysis made at the Imperial Institute of one of these products indicated that Shea butter was at least an important component. Its application for these purposes should render it possible to obtain a higher price for the fat than soap and candle makers could offer.

A sample of the Shea butter from Lagos was submitted to a firm of brokers in Liverpool, who reported it to be of the same quality as that usually received from the Niger. The value of Shea butter for candle and soap making is usually about the same as that of soft palm oil, such as Bonny or Calabar, the price of which at present is £24 5*s.* to £24 10*s.* per ton. The brokers stated that there is a fair demand for Shea butter, and consignments are readily saleable.

SEEDS OF *Mimusops* SP.

This product is of interest, since the nuts closely resemble Shea nuts in appearance but are usually somewhat larger. The botanical name of the plant is not known with certainty, but from the specimens sent to Kew, it appears to be a species of

Mimusops, probably *Mimusops Djave*, the seeds of which are known to yield a similar fat (*Rev. Fett. Harz. Ind.*, 1908, **15.** 78 and 106).

The sample examined was received from Southern Nigeria, in 1906, and consisted of nuts of light-brown colour, about 2 inches long and 1–1½ inches in diameter, with blunt-pointed ends. The shells were smooth, hard and shiny, except on one side, which bore a rough broad scar running from end to end; they were easily broken and separated from the kernel. The latter varied in colour from cream to brown, possessed a curious fruity odour and an unpleasant, bitter taste. The kernels formed 62·7 per cent. by weight of the whole nuts.

The yield of fat on extraction by solvents was 60·2 per cent. from the kernels, corresponding to 37·7 per cent. from the whole nuts. The fat was solid at the ordinary temperature, nearly white, and resembled Shea butter. It gradually developed a slightly rancid odour on exposure to the air. On examination it gave the following results:—

Specific gravity $\frac{100°C.}{15·5°C.}$	0·860
Acid value	25·3
Saponification value	187·6
Iodine value	56·2
Hehner value	95·4
Reichert-Meissl value	nil.
Unsaponifiable matter	2·6 approx.
Titer test	47·8°

The kernels would probably be of about the same value as Shea kernels (see above). The "constants" of the fat correspond closely with those of Shea butter.

"DIKA" NUTS FROM SOUTHERN NIGERIA.

A description of the nuts and of the fat obtained from the kernels has been given already in this *Bulletin* (1906, **4.** 19). Since then several other samples of the nuts and kernels have been received for examination, and the results of these may now be given. The proportion, by weight, of kernels in the nuts varies from 18 to 20 per cent.

The yield of fat from the kernels and the characters of the fat obtained are given in the following table:—

	Sample No. 1.**	Sample No. 2.	Sample No. 3.
Yield of fat (on kernels)	54·3	60·1	66·3
Specific gravity at 100°/15°C.	—	0·863	—
Acid value	6·6	12·6	1·8
Saponification value	244·5	250·0	243·8
Iodine value	5·2	3·34	4·2
Unsaponifiable matter	0·73	—	—
Titer test	34·8°	—	—
Melting-point of fat	—	—	39·2°C.

** This sample was examined by Dr. Lewkowitsch, *Analyst*, 1905, 394.

The fat, as indicated in the previous report, is pale yellow or almost white, and is rather harder than coco-nut oil. Commercial experts who have examined the kernels and oil state that the latter would have for ordinary technical purposes, such as soap-making and candle-manufacture, about the same value as palm kernel oil, viz. £27 5*s*. per ton.

PENTADESMA BUTYRACEA FAT.

A small sample of this material, as received in July of the present year from Sierra Leone, consisted of pale, greyish-coloured, granular fat, with an odour like that of Shea butter. The fat contained a good deal of suspended impurity, and after filtration and cooling had a greenish-yellow tinge.

Specific gravity at 100°/15·5°C.	0·859
Acid value	3·6
Saponification value	190·1
Iodine value	41·8
Titer test	50·7°
Hehner value	95·0
Unsaponifiable matter	1·7
Reichert-Meissl value	nil.

No previous analyses of this fat are available for purposes of comparison (cf. *Ann. Inst. Col. Marseilles*, 1903, Pt. 2. 13). From its appearance and chemical constants it seems possible that it might be used for the manufacture of edible fats; but

practical trials would be necessary to determine this. If unsuitable for the above purpose it might find a market for candle manufacture, in which case, however, its value would not be so high. If available in large quantities this fat would no doubt be saleable in this country, but technical trials on a large scale would have to be made in order to ascertain its commercial value definitely.

"MAFOUREIRA" NUTS.

In a previous number of this *Bulletin* (1903, **1.** 26) an account was given of the results of examination of these nuts. They appear to be exported in considerable quantities from East African ports from time to time, and lately they have been used in Natal as a source of fat for soap-making (cf. *Natal. Agric. Journ.* 1907, **10.** 1471). The consignment now dealt with came, like that examined previously, from Portuguese East Africa.

It consisted of ovoid fruits, about $\frac{3}{4}$ inch long and $\frac{1}{2}$ inch broad, composed of a chocolate-brown shell, more or less covered with a reddish oily pulp, enclosing a single dull greyish-brown kernel, which readily splits into two parts. The kernels break with a granular fracture and readily yield oil under the pressure of the finger-nail.

The nuts were sent to a manufacturing firm for technical examination. The kernels yielded 54·46 per cent. of fat, and the husks 50·37 per cent.

The fats obtained from both the husks and kernels were solid and of dirty-green colour; they could not be bleached by any of the ordinary processes used in bleaching fat for soap-manufacture.

	Present Sample.		*Previous Sample.*	
	Fat from kernels.	Fat from husks.	Fat from kernels.	Fat from entire nuts.
Acid value . .	36·7	17·7	42·4	52·5
Saponification value .	200·3	209·7	241 *	240 *
Iodine value . .	52·6	71·6	47·8	55·8
Titer test . . .	53·2	45·4	—	—
Unsaponifiable matter	1·4	1·3	—	—

* These values, which were wrongly given as 24·1 and 24·0 in the previous Report (*loc. cit.*), are higher than those generally recorded; but recent determinations of the saponification values of the original samples of fat confirm them.

The tallow obtained by expression from the seeds has also been examined recently by Daniel and McCrae (*Analyst*, 1908, **33**. 276), who found the following values: saponification value, 201; iodine value, 43·5; and unsaponifiable matter, 1·2 per cent.

In reporting the results of the commercial trial, the firm stated that the dark colour of the fat would render it unsuitable for making the better qualities of soap, and that, in consequence, it would only realise the price of "soft, off-coloured tallow" for soap-making purposes.

The cake left after the extraction of the fat in these experiments contained a larger quantity of fat (25·8 per cent.) than would probably be left in the cake in working on the commercial scale. The yield of fat obtained from the nuts in actual manufacturing operations would therefore probably be larger than the figures recorded above. A chemical examination showed that the cake contained 3·49 per cent. of nitrogen, equivalent to 4·4 per cent. of ammonia, and the equivalent of 1·5 per cent. of phosphoric anhydride.

These results show that the nuts furnish a satisfactory yield of solid fat, which is, unfortunately, of rather dark colour; and information received from other manufacturers who have tried this material as a source of fat, confirms the view that it is difficult to bleach. The cake left after the removal of the fat is unsuitable for use as a feeding material, since it is very bitter and probably possesses emetic properties. It could probably be sold as a manure, for which purpose it would, however, be inferior to cotton-seed cake and rape-seed cake.

PYCNANTHUS SEEDS.

Fruits, seeds and mace derived from *Pycnanthus* sp. have been received from Northern Nigeria and Uganda for examination as oil-yielding materials.

Sample from Northern Nigeria.—The fruits of a species of Pycnanthus, probably *Pycnanthus Kombo*, Welw., were included in a collection of products from Northern Nigeria, sent to the Imperial Institute in 1906.

The fruit is of the size of a small oval plum, and in the dry state weighs about 4 grams; it easily breaks up into two thick hard pieces of husk, and an inner nut covered with a false aril,

corresponding to the mace of the common nutmeg derived from *Myristica fragrans*, to which the genus Pycnanthus is nearly allied. The Pycnanthus seeds, it should be stated, are frequently mistaken for nutmegs, though they have no aroma and are devoid of volatile oil.

The "mace" is deep brown, almost black, in colour. It possesses a slight fragrance, and was therefore examined for essential oil, but no appreciable quantity was present.

The nut has a very thin shell, which is easily removed from the contained kernel. The latter is white internally, with dark, brown rays penetrating it from the exterior; it is easily cut and has a very bitter taste, which would preclude the possibility of utilising the "cake" left after the extraction of the fat as a cattle food. The ground kernels were extracted by light petroleum, and yielded 54 per cent. of a hard solid fat, of orange colour and bitter taste. It had the following constants:—

Specific gravity 100°/15° C.	0·886
Melting-point	48·5 C.
Saponification value	235–245
Acid value	21·0
Hehner value	90·8
Iodine value	48·9
Titer test	45·8°

The fat would probably be suitable for soap-making, though the soap made from it would be rather dark in colour. It might also be used in the manufacture of candles.

The residual meal is fairly rich in nitrogen, and might be used as a manure.

The nuts are similar to, if not identical with, a product which has occasionally been exported from West Africa to Liverpool and Hamburg, for use as an oil seed, under the name of "Kafu," or "African oil" seeds. These seeds have been described as containing 73 per cent. of a solid fat, which, it has been suggested, might be used for making candles.

Samples from Uganda.—The material received from Uganda consisted of the nuts and mace of *Pycnanthus Schweinfurthii.*

Nuts.—These were small nut-like fruits, the shells of which were thin, fragile, dark brown and glossy, with irregular, longi-

tudinal furrows. The kernels were small, egg-shaped, ¾ inch long and ½ inch broad at the widest end; they were brown externally, and yellowish-white internally, with isolated brown patches due to invaginations of the seed coat.

The kernels yielded to solvents 60·2 per cent. of fat, which was fairly hard at ordinary temperatures (15° C.), and was of dark-brown colour; it had a slight peculiar rancid odour, and a faintly bitter taste. On examination it gave the following results:—

	Crude Fat.	*Refined Fat.*
Specific gravity 99°/15° C.	0·887	—
Acid value . . .	26·5	nil.
Saponification value . .	255·0	183·0
Iodine value . . .	65·4	33·7
Hehner value . . .	90·9	—
Titer test . . .	37°	37·6°

The fat extracted from the kernels possessed a high acid value, and darkened in colour when treated with alkalis. Consequently it would have to be refined before being used for soap-making. The only satisfactory method of accomplishing this is to treat the fat with alkalis, which involves the loss of all the free fatty acids. The refined product thus obtained, the constants of which are given in the second column of the table, is a clear, pleasant-smelling, butter-yellow fat, suitable for soap-making. The firm of soap-makers who examined these nuts for the Imperial Institute, stated that the heavy loss involved in refining the oil renders it doubtful whether the nuts could be successfully utilised commercially, but as the kernels are very rich in fat it is possible that it would be worth while to make use of them, especially if they are obtainable in very large quantities at a low cost.

"*Mace.*"—This consisted of flat, dark, orange-brown, oily pieces, ¼ to 1¼ inch long, resembling ordinary "mace" in form, but smaller, darker in colour, and devoid of aroma. The taste was oily, bitter and acrid. The material yielded to solvents 57·04 per cent. of oil. This was of dark, orange-red colour, fluid and translucent in thin layers at first, but on standing it deposited a considerable quantity of a semi-crystalline

substance. It develops a deep violet colour when treated with alkalis.*

Specific gravity 99°/15° C.	0·866
Acid value	40·7
Saponification value	214·0
Iodine value	77·45
Hehner value	91·2
Titer test	35°

Owing to the dark colour of the oil, which can only be decolorised satisfactorily by treatment with alkali, involving the removal of the large amount of free fatty acid present, it seems unlikely that this "mace" can be used commercially as a source of oil. The product is devoid of aroma, and cannot therefore be used as a substitute for true mace.

RAPHIA WAX.

IN a communication made to the Paris Academy of Sciences in December 1905, Professor M. H. Jumelle of Marseilles drew attention to a vegetable wax, prepared by the natives in certain districts of Madagascar, from the leaves of the raphia palm (*Raphia Ruffia*), well known as the source of the "bass" used by gardeners for attaching plants to stakes. A fuller account of the preparation of this material was given in the *Bulletin Economique de Madagascar* (1906, **6.** 48). As it appeared, from the first accounts published, that this product might be of some economic value, the Director of the Imperial Institute applied to H.M. Consul at Tamatave for samples of the wax, and these were supplied early in 1907. The wax has now been examined, and submitted for technical trial to manufacturers. As the results of this work present many points of interest, it has been thought desirable to give a short account of it in the *Bulletin*.

Raphia bass consists of the epidermal portion of the upper side

* This substance might be included more appropriately in Group A. (liquid or semi-liquid non-drying oils), but it is convenient to place it near the Pycnanthus seeds from which it is derived.

of the leaf of the raphia palm. When the leaf opens out, the two surfaces which have been in contact in the young stage form the upper surface of the leaf. This has a glossy epidermis, which, on being stripped off, forms the raphia bass. It is on the dull under surface of the leaf that the wax occurs as a whitish layer or bloom, readily detachable by rubbing lightly with the finger.

It is from the residues of the leaves left after the extraction of the bass, that the wax has, up to the present, been obtained. These residues, called by the natives "Taimbontgona," are available in large quantities in the neighbourhood of the raphia groves which have been worked for bass. They are spread out to dry on cloths in the open air, sheltered from the wind, as even a slight breeze is sufficient to blow away much of the light waxy matter. The drying usually takes from two to four days, and at the end of that time a white pellicle is apparent on the under surfaces of the leaves. It is then only necessary to shake the leaves or to rub them between the hands to cause the waxy matter to detach itself, mostly in the form of powder or fine dust. The powder is collected, sifted from foreign material, and placed in boiling water, when the wax melts and floats to the surface, whilst any earthy impurity settles to the bottom. The liquefied wax is then transferred to a receiver, where it is allowed to cool and solidify. The product thus prepared is yellow to dark brown in colour, rather harder and more brittle than beeswax.

The following quantities are given as the yields of bass and wax in an experimental extraction of these products in Madagascar. The experiment was made on ten raphia palm leaves of medium size (3½ to 4½ metres in length).

	Kilos.
Total weight of leaves	104·5
Weight of dry bass obtained	4·6
Weight of dry residue (less the ribs of leaves)	11·0
Weight of wax after preparation	0·78

In this experiment the yield of wax was equal to 0·75 per cent. of the weight of leaves used, and to about 17 per cent. of the weight of dry fibre extracted. In practice, however, it would be lower, and possibly equal to about 10 per cent. of the weight of fibre.

Examination of the Wax.

Professor Jumelle showed that in many respects this product resembles the carnauba wax of commerce, obtained from *Copernica cerifera*. It has approximately the same melting-point (83° C.), and behaves in the same way towards various solvents. Raphia wax has been subjected to a more detailed examination by Prof. Haller and M. Descude. The results of these investigations indicate that although in physical properties raphia wax resembles carnauba wax to some extent, the two differ considerably in composition.

Two samples of the raphia wax were received at the Imperial Institute. The first consisted of a solid cake weighing 330 grams. It was yellowish brown in colour, for the most part, but greyish at the edges, and was sufficiently brittle to powder in a mortar.

The second sample was larger, and consisted of two cakes weighing together eight pounds. The lower part of one of these cakes contained a large quantity of sandy or gritty impurity due to careless preparation. Only the upper portion of this was taken for chemical examination.

The results are given in the following table, which also includes, for the purpose of comparison, the corresponding values for carnauba wax and beeswax.

	Raphia wax. 1	Raphia wax. 2	Carnauba wax.	Beeswax.
Specific gravity at $\frac{99° \text{ C.}}{15{\cdot}5° \text{ C.}}$	0·836	0·832	0·842	0·820
Acid value	4·9	6·5	3·4–7·0	19–21
Saponification value . . .	51·3	50·3	79–84	90–99
Iodine value	7·68	10·7	13·5	8–11
Melting-point of wax . .	82° C.	83° C.	83°–86° C.	63°–65° C.

Results of Technical Trials.

The results of the comparative examination showed that the raphia wax agreed closely in physical characters with carnauba wax, and it was considered likely that it might be used for the same purposes, such as the manufacture of polishes, candles, etc.

A firm of boot-polish manufacturers, who were consulted on

this point, were at first inclined to view the product favourably, and asked for a larger sample for trial. Unfortunately the second large sample received at the Imperial Institute, as indicated above, contained a good deal of gritty impurity, and this the manufacturers reported rendered the material unsuitable for their purpose.

A firm of candle and soap manufacturers who were also consulted, reported that in some respects the material possessed the qualities of certain waxes already on the market, and although they took exception to the inherent "oiliness" and the dark colour of the wax, they expressed their willingness to purchase a small consignment at the rate of £40 per ton, for trial on a large scale. Inquiries made by H.M. Consul at Tamatave as to the possibility of obtaining commercial supplies of the wax, indicate that a price of £40 per ton would not cover the cost of collecting, preparing and shipping the wax, and that the latter cannot be produced at present for less than £80 per metric ton f.o.b. Tamatave.

As the present price of carnauba wax ranges from £4 10*s.* to £7 per cwt., it is possible that if raphia wax of good quality, pale colour, and free from grit could be shipped in quantity at £80 per ton, it might find considerable use as a substitute for carnauba wax.

COTTON FROM BRITISH GUIANA.

DURING the year 1908 a number of samples of cotton have been forwarded to the Imperial Institute from British Guiana by the Director of Science and Agriculture, and have been examined in the Scientific and Technical Department, and submitted to commercial experts for valuation.

The first consignment consisted of five samples of cotton of which Nos. 1, 2, 4, and 5 had been grown in the heavy clay soil of the Government Experimental Fields, whilst No. 3 had been grown on lighter lands at the Plantation, Leonora. It was requested that the samples should be compared with previous specimens of the same cottons, which were the subject of a report in 1907.

Special interest was attached to Nos. 4 and 5, the former having been grown from ordinary non-selected seed, whilst the latter was the result of two selections, made in 1906 and 1907, from vigorously growing plants, which appeared to be withstanding the detrimental effects of the heavy clay soils.

A description of these cottons is given in the following table (p. 385).

The "Buck" or native cotton appeared to be slightly less "silky," but perhaps more even in colour, than the sample previously examined at the Imperial Institute. No other difference was noticeable, and the cotton may therefore be stated to have retained its good qualities.

The sample of "Caravonica silk" cotton (No. 2) was softer and finer than the specimens previously submitted. It approached much more nearly to Egyptian or Sea Island cotton in type. Sample No. 3 was similar to the "wool" and "kidney" varieties of Caravonica cotton included with the previous specimens, but was slightly inferior in colour.

The Mitafifi cottons did not appear to have undergone any great change, although the cotton grown from selected seed was slightly more uneven in colour than the corresponding cotton in the previous samples. Apart from this no difference was observable.

The valuations quoted in the present report are lower than those obtained for the samples reported on in 1907. This, however, is due to the fall in the market prices of cotton, and not to any deterioration in the quality.

A later consignment of cotton consisted of six samples of varieties cultivated by the aboriginal Indians on the Savannahs in the southern part of the colony. It was stated that these cottons had been so long under cultivation by the Indians that they had become practically indigenous.

The quality and characters of these samples are recorded in the following table (p. 386).

These samples of cotton compare favourably with standard specimens of commercial varieties, and all of them would be readily saleable in this country. The "Suwad" cotton, which resembles an improved American Upland variety, is of very superior quality, and would probably be in greater demand in

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Number or mark of sample	"Buck" Native Cotton.	"Caravonica Silk."	"Caravonica Cotton from Plantation, Leonora."	"Mitafifi Cotton."	"Selected seeds, Egyptian Mitafifi var."
Description	Clean, ginned cotton, soft, very lustrous, of even pale cream colour, and entirely free from stains.	Clean, ginned cotton, soft and rather silky, lustrous, of an even cream colour, and generally free from stains.	Clean, ginned cotton, rather "woolly," lustrous, of an even cream colour, and entirely free from stains.	Clean, ginned cotton, soft, lustrous, entirely free from stains but mixed in colour, being generally pale reddish-brown with a small proportion of white cotton.	Clean, ginned cotton, soft, lustrous, entirely free from stains, but rather uneven in colour, varying from light reddish-brown to pale cream.
Strength	Normal.	Normal.	Normal.	Normal.	Generally normal.
Length of fibres . . .	Very irregular, varying from 1·2 to 2·1 in.	1·4 to 1·8 in.	1·4 to 1·8 in.	Light brown cotton, 1·2 to 1·6 in. White cotton, 1·5 to 1·9 in.	1·3 to 1·7 in.
Diameter of fibres . .	0·0004 to 0·0011 in.; average, 0·00065 in.	0·0004 to 0·0010 in.; average, 0·00071 in.	0·0005 to 0·0010 in.; average, 0·00074 in.	0·0004 to 0·0010 in.; average, 0·00069 in.	0·0004 to 0·0010 in.; average, 0·0007 in.
Microscopical characters	No immature fibres noticed.	No immature fibres noticed.	No immature fibres noticed.	No immature fibres noticed.	A small quantity of immature fibres noticed.
Commercial value . .	About 9*d.* per lb. (with "good" Abassi at 11*d.* per lb., and "middling" American at 6·04*d.* per lb.).	About 9½*d.* per lb. (with "good" Yannovitch at 11¼*d.* per lb.).	About 8½*d.* per lb. (with "good fair" moderately rough Peruvian at 9*d.* per lb.).	About 7½*d.* per lb. (with "fully good fair" brown Egyptian at 8$\frac{5}{16}$*d.* per lb.).	About 9½*d.* per lb. (with "fully good fair" brown Egyptian at 8$\frac{5}{16}$*d.* per lb.).
Remarks	The chief defect of this cotton was its very irregular length. It approximated in character to an Egyptian or Sea Island cotton.	This sample was of excellent quality, approaching Egyptian Yannovitch in character; it resembled sample No. 1, but was rather more "silky."	This cotton was of very good quality. It was of Brazilian or Peruvian character, and harsher than samples Nos. 1 and 2.	This cotton had probably been grown from mixed seed; on this account it was somewhat depreciated in value, but would be saleable as a lower quality of brown Egyptian.	This cotton was of much better quality than No. 4, but was rather mixed. It would be readily saleable.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Number or mark of sample	"Kineabu, the common cotton of the country."	"Suwad."	"Awintearda."	"Wisadie."	"Bisa Tail."	"Purume."
Description	Three-lobed cotton bolls of average size.	Unginned cotton.	Unginned cotton.	Unginned cotton.	Unginned cotton.	Unginned cotton.
Lint	Rather "woolly," lustrous, of pale cream colour with a small quantity of yellowish-brown stain. Yield on ginning, only 23 per cent. Easily detachable from seed.	Soft, lustrous, of an even cream colour, and generally free from stains. Yield on ginning, 29 per cent. Not easily detachable from seed.	Rather harsh, lustrous, of a fairly even cream colour, generally free from stains. Yield on ginning, 31·5 per cent. Very easily detachable from seed.	Rather harsh, lustrous, of an even cream colour, generally free from stains. Yield on ginning, 31 per cent. Fairly easily detachable from seed.	Rather harsh, of an even cream colour, entirely free from stains. Yield on ginning, 35 per cent. Fairly easily detachable from seed.	Rather harsh, lustrous, of even pale cream colour, entirely free from stains. Yield on ginning, 25 per cent. Easily detachable from seed.
Seed	"Kidney" variety in clusters of from 6 to 9 seeds. Generally smooth and dark brown, occasionally invested with a bright green down. All seeds examined were healthy.	Rather large, and generally closely invested with a brownish-green or green down. All seeds examined were healthy, and showed no signs of the attack of insect pests.	Occasionally adhering together in twos and threes, large, generally smooth and dark reddish-brown, a few partially covered with light brown down. Six per cent. of seeds examined were withered, but there were no signs of the attack of insect pests.	About one-third were of the "kidney" variety, occurring in clusters of six to eight smooth seeds; the remainder were single and covered with a light reddish-brown down. All seeds examined were healthy.	Of medium size and generally covered with a short, light brown down; some seeds only partly covered. Eight per cent. of seeds examined were withered, but there were no signs of the attack of insect pests.	"Kidney" variety, in clusters of from 5 to 9 seeds; generally smooth and dark brown. Eight per cent. of the seeds examined were withered.
Strength	Generally normal; some portions rather weak.	Generally normal.	Generally normal.	Normal.	Normal.	Normal.
Length of fibres	1·2 to 1·5 in.	1·3 to 1·7 in.	1·2 to 1·6 in.	1·3 to 1·7 in.	1·2 to 1·6 in.	1·2 to 1·5 in.
Diameter of fibres	0·0006 to 0·0012 in.; average 0·00082 in.	0·0004 to 0·0009 in.; average 0·00968 in.	0·0005 to 0·0011 in.; average 0·00080 in.	0·0005 to 0·0012 in.; average 0·00083 in.	0·0005 to 0·0013 in.; average 0·00080 in.	0·0005 to 0·0012 in.; average 0·00081 in.
Microscopical characters	Some immature fibres were noticed.	A small quantity of immature fibres noticed.	Fibres generally fully mature.	A small proportion of immature fibre noticed.	No immature fibres noticed.	No immature fibres noticed.
Commercial value	About 7*d.* per lb. (with "fair" Pernam at 6·53*d.* per lb. and "good fair" moderately rough Peruvian at 8·50*d.* per lb.).	About 8*d.* per lb. (with "middling" American at 5·68*d.* per lb. and "good" Abassi at 10¼*d.* per lb.).	About 7½*d.* per lb. (with "fair" Pernam at 6·53*d.* per lb. and "good fair" moderately rough Peruvian at 8·50*d.* per lb.).	About 7½*d.* per lb. (with "fair" Pernam at 6·53*d.* per lb. and "good fair" moderately rough Peruvian at 8·50*d.* per lb.).	7½*d.* to 8*d.* per lb. (with "fair" Pernam at 6·53*d.* per lb. and "good fair" moderately rough Peruvian at 8·50*d.* per lb.).	About 8*d.* per lb. (with "fair" Pernam at 6·53*d.* per lb. and "good fair" moderately rough Peruvian at 8·50*d.* per lb.)
Remarks	The cotton was of good quality and character, resembling that of Brazilian. It would be readily saleable, but was somewhat depreciated by the presence of stained portions.	The cotton was of excellent quality and of a character approximating to that of Egyptian Abassi.	This cotton was of similar character to that of No. 1, but was of better colour; it was of very good quality.	This cotton was slightly darker in colour than sample No. 3, but was of very similar quality.	This cotton was similar to No. 4.	This cotton was of excellent quality, similar to sample No. 1, but of better colour.

the English market than those of the rougher Brazilian character, which although excellent cottons would be somewhat more limited in their applications.

The yield of lint from the "Kineabu" and "Purume" cottons (23 and 25 per cent. respectively) is lower than usual for "kidney" cotton, which generally furnishes about 28 per cent. All the cottons had been well grown and did not show any signs of the attack of insect pests.

FIBRES FROM FIJI.

THE fibres described in the following report were forwarded from Suva, Fiji, in December, 1907, for examination and valuation. They consisted of very carefully prepared specimens of Sisal, Mauritius and bowstring hemps, and of ramie ribbons and filasse.

SISAL HEMP.

It was stated that this sample had been grown in the Government House grounds, and prepared by a Death and Ellwood fibre machine. It consisted of perfectly cleaned and nearly white fibre, of very good lustre and even diameter. The product was from 4 to 5 feet long, and of very good strength.

On chemical examination, it yielded the following results:—

	Present sample from Fiji. *Per cent.*	Sisal hemp from British East Africa for comparison. *Per cent.*
Moisture	8·7	11·1
Ash	0·5	1·0
α-Hydrolysis (loss)	8·5	11·2
β-Hydrolysis (loss)	10·7	14·1
Acid Purification (loss)	0·9	2·3
Cellulose	79·0	78·2

This fibre was of excellent quality, superior in composition to many samples of Sisal hemp previously examined at the Imperial Institute, and would be valuable for rope-making. The commercial experts to whom the fibre was submitted considered

that it was worth £34 to £35 per ton (with Mexican Sisal at £25 to £27 per ton), and that it would be a strong competitor of the Sisal hemp now produced in German East Africa.

MAURITIUS HEMP.

This fibre was stated to have been prepared at the Government Experimental Factory, Fiji, from leaves grown at Koronibello, Bua, Vanua Levu.

It was soft, well prepared, of good colour, lustre, and strength, and from 4 to 6 feet long.

The results of its chemical examination are given in the following table, to which, for convenience of comparison, are added the results yielded by a sample of the fibre from Mauritius.

	Present sample from Fiji. *Per cent.*	Sample from Mauritius. *Per cent.*
Moisture	9·5	13·0
Ash	1·0	2·5
α-Hydrolysis (loss)	14·0	7·5
β-Hydrolysis (loss)	16·5	18·3
Acid purification (loss)	5·1	2·0
Cellulose	78·0	76·4

The results of the chemical examination show this fibre to be superior to the sample from Mauritius which was examined at the Imperial Institute. It was of good length and strength, and would make excellent ropes. The fibre was valued by commercial experts at about £31 per ton (with "good average" Mauritius hemp at £22 10*s.* per ton).

BOWSTRING HEMP.

This fibre, derived from *Sansevieria guineensis*, was prepared at the Government Experimental Factory from leaves grown in the Government House grounds.

It was an excellent specimen, nearly white, of good lustre, fairly even diameter and good strength, and 2½ feet long.

On chemical examination, it gave the results which are tabulated and compared below with those furnished by a sample from Sierra Leone.

	Present sample from Fiji. *Per cent.*	*Sansevieria guineensis* from Sierra Leone. *Per cent.*
Moisture	8·6	10·6
Ash	0·5	0·4
α-Hydrolysis (loss)	9·1	8·9
β-Hydrolysis (loss)	12·1	13·9
Acid purification (loss)	1·3	1·8
Cellulose	75·0	78·0

This fibre compared very favourably with previous samples examined at the Imperial Institute, but was rather short for rope-making. It was regarded by commercial experts as worth about £27 per ton.

Conclusions.

These three fibres were of superfine quality, and would be readily saleable in large quantities. The bowstring hemp was, however, rather short, and it was recommended that efforts should be made to obtain a fibre of longer staple, since the shortness detracts considerably from its value.

The commercial experts, to whom the fibres were submitted, stated that they would be interested to learn whether commercial supplies are likely to be available in the near future.

RAMIE.

Two samples of ramie were received, one consisting of ribbons and the other of filasse.

The ribbons, said to have been obtained by passing the stems through a Death and Ellwood fibre machine, were clean, well-prepared, of pale-greyish straw colour and much stiffer than a standard sample of hand-scraped China grass. The strength was normal and the length of staple 24 to 36 inches; for comparison it may be stated that a standard sample of China grass had a maximum length of 42 inches. A somewhat prolonged treatment of the ribbons with dilute alkali resulted in the production of a clean lustrous fibre.

The commercial value of ramie ribbons of the quality of this sample would probably be about £25 per ton in London, with hand-scraped China grass at from £25 to £30 per ton. It was pointed out, however, that the demand for ramie is somewhat

limited, and that it would therefore appear advisable to proceed very cautiously with the development of the industry.

The sample of "filasse" consisted of very lustrous fibre, which was of even pale cream colour. When tested for strength and elongation in comparison with standard samples, it was found to be somewhat inferior, as is shown by the following table:—

	Strength. *Grams.*	Elongation. *Per cent.*
Standard sample (a) .	36·10	2·80
" " (b) .	42·70	3·00
Ramie from Fiji .	29·67	2·34

The ultimate fibre had a maximum length of 10 inches and a diameter of 0·0010 to 0·0025 inch, with an average of 0·00162 inch. Microscopical examination showed that the material had the characteristic structure of ramie.

The sample was not in a state suitable for the market, as manufacturers usually prefer to buy the scraped ribbons and to "degum" the material and prepare the filasse themselves.

BITINGA RUBBER FROM *RAPHIONACME UTILIS*.

CONSIDERABLE interest has been aroused recently by the discovery in Portuguese West Africa of a plant, bearing various native names, such as "bitinga," "ecanda" and "marianga," the tuberous roots of which contain a rubber-yielding latex.

Several specimens of the rubber and of the roots of the plant from which it is obtained have been received at the Imperial Institute from the Mozambique Company, and as the results of their examination are of some general interest it has been considered desirable to summarise these in the *Bulletin*.

Rubber.

The samples of rubber consisted of three roughly cylindrical pieces, which differed considerably in quality owing to the inclusion of varying amounts of impurities. The cleanest specimen, which however contained an appreciable amount of impurity

consisted of pale yellowish-brown rubber exhibiting good elasticity and tenacity. The other two pieces were darker in colour; one of them contained a considerable quantity of vegetable impurity, whilst the other was impregnated with fine sand. In both cases, however, the physical properties of the rubber were fairly good.

The light-coloured rubber was chosen for analysis as more likely to represent a well-prepared product, and this gave the following results:—

	Sample as received. *Per cent.*	Composition of dry rubber. *Per cent.*
Moisture	1·0	—
Caoutchouc	76·8	77·6
Resin	9·0	9·1
Proteids	0·6	0·6
Insoluble matter	12·6	12·7
Ash (included in "insoluble matter")	7·11	7·18

These results indicate that the rubber would be of good quality, so far as chemical composition is concerned, if it were not for the presence of the large amount of insoluble impurity which considerably reduces the percentage of true caoutchouc. The amount of resin is somewhat high, but the percentage of proteid is exceptionally low.

A portion of this sample was valued by commercial experts at 1*s.* to 1*s.* 3*d.* per lb., but they stated that the rubber, if clean, should be worth 3*s.* per lb., or more, as compared with fine hard Para rubber at 4*s.* 10*d.* per lb. on the same date.

Roots.

A number of the tuberous roots of the plant were also received and submitted to examination. The tubers are turnip-shaped, and vary up to 5·5 inches in diameter and 4 inches in height. They are covered with a dark brown scaly bark. Many of the roots had decomposed more or less during transit, but a number were still sound, and yielded latex quite freely on incision.

Two samples of the fresher roots with unbroken bark were selected for analysis; specimen A was a single large tuber weighing about 6 ounces, whilst B consisted of two smaller

tubers which together were approximately equal in weight to A.

The results of the examination were as follows :—

	A.	B.
	Calculated on roots as received.	
Moisture	86·88	88·87
Rubber	1·52	1·04
Insoluble residue, resin and other extractive matter	11·60	10·09
Rubber (on dry roots)	11·6	9·3

The yield of rubber from the tubers as received is therefore very low (1·0 to 1·5 per cent.) owing to the large amount of water which they contain, and as these tubers must have dried considerably during transit, the freshly-collected roots will probably furnish much less than the figures recorded above. The average yield of rubber from the dry material is however fairly high, viz. 10·5 per cent.

Identification of the Bitinga Plant.

Specimens of the "Bitinga" roots were forwarded to Kew by the Mozambique Company with a view to the identification of the plant, and flowering specimens were obtained in March of this year. The plant proves to be a new species of Raphionacme of the natural order Asclepiadaceæ and has been named *Raphionacme utilis*, Brown and Stapf. A full description of the plant, including figures, was given in a recent number of the *Kew Bulletin* (1908, No. 5, p. 209).

It is probable that the Bitinga plant thus identified is identical with the "Ecanda" or "Marianga" plant discovered by Professor Geraldes, during a journey to the Upper Zambesi, in 1904–05. According to this author (*Revista Agronomica*, Vol. iii. Nos. 4 to 8; *Estudo sobre os latex borrachiferos*, p. 143), the Ecanda or Marianga plant occurs in the sandy treeless plains (*anharas*) of Bailunde and Bihé and on the sandy steppes between the rivers Quanza and Zambesi, at an altitude of 4,000 to 5,000 feet.

The natives in these districts prepare rubber from the roots by

cutting them into slices, which are then spread on the ground and exposed to the sun, whereby the exuded latex is coagulated. The rubber thus formed is rolled into small cylindrical pieces, about 5 inches long and $\frac{5}{8}$ inch in diameter. The rubber so prepared is stated to be of good appearance, but it usually contains considerable quantities of earthy impurity; thus, one sample examined contained only 45·8 per cent. of true rubber, and 51·4 per cent. of impurities.

Professor Geraldes found that the most practicable method of obtaining rubber from the fresh roots was to cut them into pieces and subject the latter to pressure. In this way the latex, much diluted with the sap of the roots, was obtained. The yield of liquid on expression amounted to about 77 per cent. of the weight of fresh roots used. From this liquid, the rubber can be prepared either by heating it or by exposing it to the air. The maximum yield of rubber obtained by Professor Geraldes in his experiments was a little less than 0·5 per cent. from the fresh roots, which is less than half the amount found in the tubers received at the Imperial Institute.

It is impossible until further particulars are available to express any opinion regarding the probable value of the Bitinga plant as a commercial source of rubber. Definite information is required as to (1) the rate of growth of the plant; (2) the age at which the tubers can best be utilised for the preparation of rubber; (3) the weight of fresh roots which can be obtained per acre; (4) the average yield of rubber; and (5) the best method of obtaining the rubber from the roots. It is understood that the Mozambique Company is conducting experiments in East Africa in order to determine these points, and to ascertain whether the plant is likely to repay cultivation.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT.

THE TECHNICAL PREPARATION OF ASBESTOS.

In a previous number of this *Bulletin* (1905, **3**. 277) a brief account was given of the different minerals to which the name

asbestos has been applied, the fibrous flexible varieties of tremolite, anthophyllite, chrysolite and krokydolite.

The only form of asbestos, however, which is of economic importance is chrysolite, or karystian stone. It occurs in veins of closely packed transverse fibres in serpentine rock, which, like the asbestos itself, is a hydrous silicate of magnesium. It is widely used for a variety of purposes, in most of which its non-inflammable character and its low conductivity for heat are the determining factors.

Almost the entire output, some 50,000 tons per annum, is derived from the open workings in the townships of Thetford and Black Lake in eastern Quebec, south of the river St. Lawrence; and it is the purpose of the present article to describe in some detail the methods of dressing the mineral and preparing it for the market, which are at present employed in this district. The same form of asbestos is widely distributed, but the only localities showing any promise of deposits capable of competing with those of Canada are the Transvaal, Western Australia, Cyprus and Newfoundland. There is a small output from Northern Italy, as well as from the United States, but it is largely of the tremolite type which commands a lower price.

It is probable that many of the methods which are here described will prove applicable to the other deposits of chrysolite, and even, to a limited extent, to the less valuable fibrous minerals.

CLASSIFICATION OF ASBESTOS PRODUCTS.

The products obtained by the dressing of asbestos include crude asbestos, short fibre or "fines," and asbestic.

Crude asbestos consists of long fibre, usually in compact masses as it occurs in the vein. This is the material mainly employed for spinning and weaving. It is as a rule divided into two grades, No. I in which the fibre measures over $\frac{3}{4}$ of an inch in length, and No. II with fibres from $\frac{5}{16}$ to $\frac{3}{4}$ of an inch long.

"Fines" includes shorter asbestos obtained by crushing the rock. It is divided into two or three grades, the poorest in quality being described as paper stock, from its use with vegetable fibre in manufacturing paper.

Asbestic is a mixture of asbestos with finely powdered serpen-

tine rock, which is employed in the manufacture of cement and mouldings.

In the Canadian mines the width of the veins and length of fibres vary from as much as 4 inches in exceptional cases to almost microscopical dimensions. The veins are irregularly distributed, and it has not been found feasible to raise the mineral at a profit except by open works.

A preliminary classification is made in the quarry itself. Long fibre, whether enclosed in rock fragments (which are reduced in size as far as practicable) or loose, is forwarded to the cobbing studs for hand dressing, while the short fibre and the rock containing it are sent to the mill for mechanical treatment.

DRESSING OF LONG FIBRE.

In the cobbing sheds the rock is broken up by sledgehammers weighing from 6 to 7 lb. The fibre is then screened in a sieve containing holes $\frac{3}{16}$ of an inch in diameter. The material passing through the screens and rock containing only short fibre are sent on to the mill, while the fibre caught in the sieve, and loose fibre collected in the mine, is cobbed with hammers weighing from $1\frac{1}{2}$ to 2 pounds on steel plates about a foot square and $\frac{3}{4}$ of an inch thick, so that any fragments of serpentine rock adhering to the fibres are broken up and separated.

The crude asbestos thus obtained is graded and cleaned by means of sieves ; those employed for No. I grade having $\frac{9}{16}$ holes and those for No. II grade $\frac{3}{8}$ holes.

In some cases the crude asbestos is separated by machinery by methods similar to those which will be described for the treatment of the rock containing the short fibre.

DRESSING OF SHORT FIBRE.

Rock containing asbestos which is not long enough to be classed as "crude" is first broken up into material sufficiently fine for the asbestos to be separated from the inclosing rock. It is next fiberised—that is to say, triturated in such a manner that the different fibres are divided one from another,—and then transferred to shaking screens, whence the fibre is carried upwards by air suction while the fine rock passes through the sieve, and any coarser material is reserved for a second fiberisation. The fibre

raised from the shaking screens passes to a chamber known as a "collector," and thence, by way of a hopper, to a revolving screen, where it is graded into two or more qualities according to the length of fibre. Each quality then passes over a screen which allows any sand that remains to fall through, while the fibre is again lifted by air suction and carried to the "settling chamber." The fibre which passes through with the sand is also taken up in the same manner by air suction, and either added to the lowest grades or collected separately as paper stock.

The processes to which the rock and intermediate products are subjected depend on the character of the material, and different arrangements are made in different mills. As far as possible the whole is carried out automatically and continuously, the product from one operation being carried to the next by elevators or conveyors.

DRYING.

At an early stage of the treatment, when it has been broken up to a convenient size, the material is dried, so that the moisture may not interfere with the subsequent processes. In favourable weather the drying may be carried out by spreading the material in a layer 2 or 3 inches deep on a wooden platform. It is usually, however, impracticable to dispense with artificial heat, which may be furnished by means of continuous steam piping covering the floor of a shed. One end of the piping is connected with the exhaust of a steam engine and the other with the open air, so that there is no extra expense for fuel. Sometimes a rotatory drier is employed, consisting of a cylinder of boiler plate 30 to 40 feet long and $2\frac{1}{2}$ to 4 feet in diameter, inclined at an angle of 7°. The cylinder rotates on friction rollers at each end, those at the lower end being grooved to keep it in position, while those at the upper end are smooth so as to allow of expansion. It is rotated at the rate of from six to eight revolutions a minute by means of an endless chain, or gearing acting on its lower end.

The whole of the cylinder except the ends is bricked in, leaving a space of about 6 inches round it, through which pass the hot gases from a furnace at the lower end.

The material to be dried is fed in at the upper end and travels down the cylinder, which is provided in the interior with longi-

tudinal blades. These lift the material as the cylinder rotates, and then allow it to fall through the hot air.

CRUSHING.

The crushing of the rock is carried out in a number of stages, the product being screened between each. The large fragments are first dealt with by a reciprocating intermittent rock-breaker of the Dodge or Blake type, fed by means of a shute, the blocks being brought forward by the attendant with the aid of a rake or pick. Sometimes two of these rock-breakers capable of dealing with fragments of different sizes are placed in series with a screen between.

After screening, the coarser material is usually dealt with in a rotatory crusher, which reduces it still more. The final crushing is carried out by means of rolls which consist of cylindrical shells of rolled steel, preferably manganese steel, fixed on cores of soft iron. The shaft of one of the rolls revolves in fixed boxes, that of the other in movable boxes, the two rolls being kept together by powerful springs which admit of their separating should a fragment larger than usual, which might break them, present itself. In some mills automatic feeders are employed. The rolls make from two to two and a half revolutions a second. Sometimes corrugated rolls are employed to produce a grinding action. The same result might be obtained by a differential movement between the rolls, but this has apparently not been tried.

FIBERISING.

The fiberiser may consist of a horizontal shaft, provided with arms about 6 inches apart, carrying teeth or knives. It rotates in a horizontal steel cylinder lined with wood, about ten times a second. The mineral is fed in from above at either end, and the teeth or knives are so adjusted that it travels to the middle, where it is discharged through an opening in the lower part of the cylinder in a finely divided state.

Another apparatus that produces a similar result is the cyclone. This consists of two beaters of chilled iron, similar in shape to a screw propeller, placed face to face in a steel case and rotated on their axes, which are horizontal and in the same straight line, in

opposite directions at the rate of about forty revolutions per second. The material treated, which is usually of the size of a walnut, is fed in on either side above the beaters, and is soon reduced to grains not exceeding a peanut in size, and fine dust which is removed by means of air suction. The beaters have to be frequently renewed, and the same is the case with portions of the lining of the case. Some of the fibre is usually torn in the process.

SCREENING AND SUCTION.

The shaking screens with which this material is now treated vary from 3 by 6 to 6 by 12 feet, and the number of pulsations is about four a second.

The pipe up which the fibre is carried by the air current is about 12 inches in diameter. At the lower end, where it takes up from the screen, it narrows in one direction to 6 inches in diameter and in that at right angles broadens to the width of the screen. The suction is created by fans from 30 to 40 inches in diameter, rotating thirty times a second. The revolving screen, by means of which the fibre is graded, is provided with arms mounted on a double shaft and moving in opposite directions, for the purpose of loosening the fibre so as to effect a better separation through the meshes.

The settling chamber which receives the graded fibre is constructed with a longitudinal hopper, through which the fibre falls on to a conveyor. Both the collectors and settling chambers are provided with an inverted chimney, by which the fine dust escapes. This is sometimes collected for use in the manufacture of finishing plaster.

The conveyors and elevators employed to conduct the material from one process to another are all of the endless belt or chain type.

Where there is any chance of "crude" asbestos being concealed in the rock, an endless rubber belt, known as a picking table, is intercalated between the rotatory crusher and the rolls. Here boys are stationed, who remove any long fibre or lumps of barren rock.

Sometimes strong magnets are employed to extract pieces of iron from the rock-breakers or other apparatus, which has

become mixed with the material treated, and might injure the machinery. The fine serpentine sand which passes through the screens usually contains a little fibre, and is sometimes ground down and sold as asbestic. Further particulars may be obtained from a memoir on asbestos by Fritz Cirkel, Ottawa, 1905, reviewed in this *Bulletin* (1906, **4**. 261).

STROPHANTHUS SEED.

SAMPLES of the seeds of various species of strophanthus are received at the Imperial Institute for examination and valuation with some frequency, particularly from West Africa. As information regarding strophanthus seeds is not readily accessible it has been thought desirable to print a short *résumé* of the information available, in this *Bulletin*, as a guide to those interested in such products.

Only one variety of strophanthus seed is employed for medicinal purposes in this country, viz. that obtained from *Strophanthus Kombé*, Oliver (N.O. *Apocynaceæ*), a rambling or climbing shrub indigenous to eastern tropical Africa. It has been observed growing in the Manganja hills, Nyasaland, at 2000 feet; in the Usamaro district, German East Africa, at an elevation of 1000 feet; and in the Yao forest, Portuguese East Africa. Livingstone refers to the use of these in the preparation of an arrow-poison by the natives in his *Narrative of a Journey to the Zambesi*, but the source of the seeds was first definitely ascertained by Sir John Kirk. Subsequently specimens of the extract were sent to England, and were recognised as containing a powerful heart poison. The plant has so far not been recorded outside East and Central Africa.

The fruit of the plant consists of two follicles, or pods, spreading at right angles, tapering from below the middle, 9 to 15 inches in length and 1 inch in thickness. The pods contain, closely packed together, a large number of seeds, each provided with a long awn. When ripe, the seeds are separated from the fruits and deprived of their awns, which, being brittle, readily break off. The long plumose awn is a remarkable feature of the

seeds, and consists of a slender brittle extension of the integument about 2 inches in length, attached to the apex, terminating in a handsome feathery tuft of hairs about 3 inches in length. Strophanthus seeds are $\frac{1}{2}$ to $\frac{3}{4}$ inch in length and about $\frac{1}{6}$ inch in breadth; in colour they vary from greyish-green to fawn, and are covered with silky hairs, which impart to them a conspicuous sheen: they possess an intensely bitter taste. When a seed is cut transversely and the section touched with sulphuric acid (80 per cent.), a green coloration is produced. The test is better carried out by immersing the seed in cold water for fifteen minutes, removing the coats, placing the blanched seeds on a porcelain plate, and then moistening with sulphuric acid. This test is generally relied on as a method of distinguishing *S. Kombé* seeds from those of the other varieties.

Up to five or six years ago, much of the strophanthus seed sold in this country was a mixture of *S. Kombé* seed with other varieties, amongst which the following were the most common.

Strophanthus hispidus, D. C.—These are distinctly brown in colour, and bear only a few, usually short, brownish hairs. Hence the seed does not possess the characteristic sheen of the official seeds. With sulphuric acid they yield a green colour. They are occasionally imported in small amounts from West Africa.

Strophanthus Nicholsoni, Holmes.—Known as "white or woolly strophanthus." The seeds are covered with white hairs, which give them a woolly and somewhat glossy appearance. With sulphuric acid they give a reddish colour. They are imported from time to time from the Gaboon.

Strophanthus gratus, Franchet.—The seeds are brown in colour, surface minutely pitted and quite hairless. They give a reddish colour with sulphuric acid.

In addition to the foregoing, the seeds of *S. Emini*, *S. Courmonti* and its varieties, *Kirkii* and *fallax*, have been found. Many of these species have proved, on testing, to be quite valueless from a medicinal point of view.

The active principle of *Strophanthus Kombé* seeds is a glucoside named *strophanthin*, of which they contain from 2 to 3 per cent. It is this substance which gives the green colour with sulphuric acid in the test referred to above. Some of the other species of

strophanthus, notably *S. gratus*, yield glucosides which possess poisonous properties, but at the present stage of our knowledge of the chemistry of these compounds, it is not at all certain that any of them are identical with the glucoside obtained from *S. Kombé*, and consequently seed of the latter species only is at present of definite economic value, although the glucosides of some of the other species are occasionally prepared and used in medicine.

Since the year 1903 practically the whole of our supply of strophanthus seeds has been exported by the African Lakes Corporation Limited. In that year the corporation sent out a competent botanist to Nyasaland, to instruct the natives how to distinguish *S. Kombé* from the other species, and to impress upon those interested the necessity of gathering that variety only. At first, by the advice of Mr. E. M. Holmes, F.L.S., the seeds were exported in pods to ensure authenticity, but now they are taken from the pod and freed from the awns; they are then packed in bales, sent down to Quilimane, Chindi or other Portuguese East African ports, whence they are shipped to England.

Exports of strophanthus seeds from Nyasaland for the four years 1904–07 are as follows:—

Year.	Weight in lb.	Value in £.
1904	10,178	2,544
1905	32,878	8,219
1906	31,477	3,935
1907	29,394	3,674

From the above figures it is seen that the demand is limited and that during the past three years it has not grown.

FLAX CULTIVATION IN INDIA.

THE cultivation of flax has been made the subject of experiments in Behar for several years. During the years 1906 and 1907 extensive areas were planted at Dhooria. In the latter year the crop was grown under the direct supervision of Mr. Em. Vanderkerkove, a practical flax expert, who was

engaged by the Indian Planters' Association with the assistance of a grant from the Bengal Government. A report on the work done and the experience gained during 1907 has been published in *The Indian Agricultural Journal*, 1908, **3**. 183.

Flax can only be grown successfully in the *rabi* season, and should not be cultivated on the same land more than once in four years. It is not advisable to manure the flax crop directly, but a good condition of the land should be ensured by the application of a liberal dressing to the previous crop. The cheapest and most suitable manures in Behar are cattle dung and rape or castor cake. The application should consist of eight tons of dung or ½ ton of oil-cake per acre.

It has been found that, in general, the best results are obtained on a soil which is intermediate between a light sandy and a heavy clay soil. The variety of soil to be selected depends, however, to a large extent on the amount of rain which has fallen. If sufficient rain is obtained in September and October, the crop will do well on fairly high land, but if the October rainfall is deficient, low-lying clay-like land is to be preferred, since it is important that there should be sufficient moisture in the surface soil to ensure even germination. The seed should be sown in October or, at latest, in the first week of November; it should be covered with soil by lightly raking and afterwards gently rolled with a log of wood. The quantity sown should be from 100 lb. to 150 lb. per acre.

With reference to the variety of seed, which should be sown in Behar, Mr. Vanderkerkove holds the view that Russian seed which has been acclimatised in France, Belgium or Holland gives the best results. Directly imported Russian or Belgium seed, however, answers very well, and such seed, acclimatised in India, gives good results for several years in succession.

The flax should be pulled when the stems commence to become yellow, and the lower leaves begin to fall. This condition of maturity is usually reached in Behar about four months after sowing.

The methods of retting usually employed in other countries are either inconvenient or unsuitable for Behar, and the following plan has therefore been adopted.

The bundles of flax straw are stood on end in ordinary indigo

vats, and packed as evenly as possible, a second layer being placed over the first, and both being kept in position by a layer of bamboos on the top. Above the flax, cross-beams are placed, about 4 or 5 feet apart. Water is admitted into the tank until it reaches the beams, the flax thus being completely covered. After a time the water becomes dark brown, and is then run out at the bottom of the vat, fresh water being introduced at the top. It has been found that retting in Behar is best effected in the cold season, as the temperature is then usually between 64° and 75° F., which gives the most satisfactory results. The best quality of fibre requires from six to ten days for retting. After retting, the flax is dried, broken and scutched in the usual way. The fibre is then graded according to quality, and baled for shipment.

The results of the experiments at Dhooria indicate that flax-growing will probably be carried on on a commercial scale in Behar, and become a profitable industry. The following is an estimate of the cost of production and the profit obtainable from an acre of flax in that district.

Yield.

	£	s.	d.
330 lb. of fibre, at £50 per ton	7	8	0
133 lb. of tow, at £15 " "	0	17	9
330 lb. of seed, at 7*s.* 3*d.* per cwt.	1	1	4
	9	7	1

Cost of Production.

	£	s.	d.
Rent	0	3	4
Cultivation	1	16	0
Securing crop	0	6	4
Preparation for retting	0	4	5
Retting	0	4	3
Scutching, inclusive of tow	0	9	7
Shipment	1	2	6
Miscellaneous	0	1	8
	4	8	1

Net profit £4 19*s.* per acre.

A scheme of future experimental work has been mapped out

and includes the testing of different varieties of flax, the acclimatisation of improved seed, seed selection, and the study of soils, rotations, methods of cultivation, manures and retting processes. It is also intended to investigate the possibility of growing flax profitably in other parts of India.

NOTES ON THE PRESENT POSITION OF COTTON CULTIVATION IN THE UNITED STATES.

A SHORT account of the cultivation of cotton in the United States, based on a report made by the Inspector of Agriculture for British West Africa, was given in a previous number of this *Bulletin* (1905, **3**. 334). The following notes have been written by Mr. J. S. J. McCall, formerly of the Agricultural College at Cairo, who has recently visited the cotton-growing States of America.

The cottons cultivated in the United States include Sea Island, Upland, and Egyptian varieties. These three classes of cotton present distinct peculiarities and special requirements, and are therefore dealt with in separate sections.

A.—SEA ISLAND COTTON.

This crop forms less than 1 per cent. of the total American cotton crop, but is of great importance owing to its high quality. It is grown to the greatest degree of perfection on James and Edisto Islands, which lie to the west and south-west of Charleston in the State of South Carolina. The largest part of this crop is grown on the coast line of South Carolina, the interior of Georgia and North Central Florida. The coast counties of Georgia and Florida produce but little cotton owing to the inferior character of the soil and the absence of necessary labour.

Crop Requirements.—Sea Island cotton is more sensitive to soil and climate than any other cotton. It is a maritime plant, excelling in quality when grown on light sand and gravel alluvia, not too rich in humus, with free drainage, a humid atmosphere, and in close proximity to the sea.

On the plantations of Messrs. Rivers, Seabrook and Hinson, which are considered to be the three best plantations on James Island, the cotton is grown without a distinct rotation. Most of the island plantations are divided into three parts, seventy-five per cent. being devoted to cotton and twenty-five per cent. to truck farming, *i.e.* the cultivation of vegetables, fodders, etc. The cotton area is divided into two equal parts, which grow cotton in alternate years. During the fallow year a few farmers grow leguminous plants, such as cow-peas or velvet beans, but cereals are never grown on the cotton land. Most of the farmers prefer to leave the land without a crop unploughed, allowing weeds to grow among the old cotton stalks, and using the field as a mule paddock. Several farmers when asked why they did not plough the land and prevent the growth of weeds, replied that "the sun hurts the ground when exposed, and therefore we prefer a covering of vegetation in summer to bare fallow." This is contrary to experience in Egypt, where the best crops are obtained after a summer bare fallow.

Much of the island-grown cotton never enters the market, but is sold privately to lace manufacturers (mostly French), at very high figures, 1*s.* 8*d.* to 2*s.* 11*d.* per pound frequently being paid for choice crops.

In planting Sea Island cotton, 5 feet is generally left between the rows and 22 inches between the plants. Planting commences in March; harvesting begins in the latter part of August and continues till December.

The island-grown cotton is much superior to the mainland crop. The inferiority of the latter is due to hybridisation with Upland cotton, which is grown in close proximity to it, and also to the lack of humidity in the atmosphere.

The mainland cultivators of Sea Island cotton say that their Sea Island crop is superior to their Upland crop when the season is warm and rainy, and *vice versa* when there is drought. The mainland-grown crop is shorter and less lustrous than the island cotton; the best results are always obtained by growing it from island-grown seed.

During the present year the island cultivators have formed a union to prevent the sale of their seed, as they say the increasing production of mainland Sea Island cotton is affecting their

prices. The Department of Agriculture at Washington have been refused seed, which they much regret, as they have no type of this cotton which does not degenerate on the mainland. This is a very narrow policy, and will probably benefit Egyptian cotton growers more than American growers, as the lower grades of Sea Island, such as that grown on the mainland, can be replaced by the higher grades of Egyptian varieties.

Possible Extension of Sea Island Cultivation.—It is considered by many that there is very little possibility of extending the Sea Island cotton industry in America, the principal reasons being that the cost of labour is very high, and that the crop gives but small returns when planted under other than the best conditions. It is more profitable to grow ordinary Upland in most districts, as it is far more certain to yield a crop, especially in seasons of drought.

Selection and Manuring.—The island cultivators are firm believers in selecting and manuring their cotton, although they object to a mixed rotation. Each of the island plantations visited had its breeding and selecting plot, and there is little doubt that the high quality of Sea Island cotton is to a large extent the result of prolonged selection in combination with the admirable natural climatic and soil conditions of the islands. The planters are a superior class of men, and exercise great care in growing and harvesting their cotton. They commence manuring the land, when farmyard manure is available, as early as November, by applying twenty loads per acre on the surface between the old ridges. As a general rule, ploughing commences at the beginning of February, when 1,000 to 1,200 lb. of cotton-seed are applied between the old ridges, if no farmyard manure was available for application in November. This seed is covered by splitting the old ridges with the plough; most of it decays, but any which germinates is destroyed in subsequent ploughings. In this practice the island cultivators confirm Egyptian experience, as they find large late applications of slow-acting organic nitrogenous manures interfere with germination and retard ripening. It is generally considered that all blooms which appear after the first week of September never mature, as they are checked by cold or frost.

The first ploughing is deep (12 inches when possible) and

subsequent ploughings shallow. The first deep ploughing encourages deep rooting, making the plants more drought-resisting. The shallow ploughings give fine surface "tilth," which is so necessary for germination and rapid early growth.

When the soil is ready for ridging a dressing is given, either in the drill or on the flat, consisting of 600 lb. of Peruvian guano and 50 lb. of potassium sulphate per acre, and after germination 50 lb. of nitrate of soda are applied.

By this treatment, combined with judicious selection, Captain Rivers of James Island raises the finest Sea Island cotton. The 1906–1907 crop of 419 lb. of lint per acre was sold privately to a French firm at 2*s*. 6*d*. per lb., or a gross return of over fifty pounds sterling per acre.

Marketing and Shipping.—Railway Rates.—The island-grown crop is marketed in bags 7½ feet long by 2½ feet in diameter, containing approximately 350 lb. of lint. This cotton is never compressed in bales as this is considered detrimental to the fibre. The crop is practically all sold in Charleston, and forms 35 per cent. of the cotton marketed at that port, selling at from 1*s*. 3*d*. to 2*s*. 6*d*. per lb.

The mainland Sea Island, which is by far the larger crop, is principally marketed and shipped from Savannah, the largest port on the Atlantic seaboard of the cotton-belt. This cotton, like Upland cotton, is sent from the farms to the cotton factors in uncompressed bales of between 400 and 500 lb. The factors take samples (from 2 to 5 lb.) from each bale, and expose them in their sample rooms for sale, the price being fixed by the grade and the cotton-exchange fluctuations. The charge for factoring varies from 4*s*. 2*d*. to 6*s*. 3*d*. per bale, irrespective of class, species, or value of cotton. This charge covers insurance for the first fortnight the bale is in the factor's hands, but, if held over, an extra charge of 2*s*. 1*d*. is made for storage.

The railway rates for transport vary, but the following figures give an approximation :—

Statesboro to Savannah, 60 miles distance, 11*d*. per 100 lb.
Macon to Savannah, 191 miles distance, 1*s*. 5*d*. per 100 lb.
Valdosta to Savannah, 100 miles distance, 1*s*. 3½*d*. per 100 lb.
Americus to Savannah, 198 miles distance, 1*s*. 10½*d*. per 100 lb.
Albany to Savannah, 170 miles distance, 1*s*. 4½*d*. per 100 lb.

After the bales are sold they are compressed for shipment, the cost being borne by the purchaser, the usual charge being 4*s.* 2*d.* per bale. Shipment to Liverpool costs from 1*s.* 5½*d.* to 2*s.* 1*d.* per 100 lb., depending on the time of the year.

The mainland Sea Island cotton is classified according to length into "East Floridas," 1¾ to 2 inches; "Floridas," 1⅝ to 1¾ inches; "Georgias," 1⅝ inches; and further graded according to strength, cleanness and evenness of staple, into "fancy," "extra choice," "choice," "extra fine," "fine," and "dogs." The average mainland Sea Island cotton realises from 17 to 25 cents per lb.

B.—UPLAND COTTON.

I. *Short-stapled.*

Upland cotton is the principal cotton of commerce, and is very extensively cultivated in every State of the American cotton belt.

The principal Upland cotton States are—South Carolina, Georgia and Alabama, on the east side of the Mississippi; and the eastern half of the immense State of Texas on the west side of the Mississippi. It is considered that Georgia and Alabama grow the best short-stapled Upland, one of the best varieties in this country being "Cook's improved." The soil of Georgia and Alabama is red and rich in iron, much of it being light and specially suitable for fruit-growing, which is an important industry in those two States. This soil responds to liberal manuring, but large areas are producing under 100 lb. of lint per acre, owing to continued cotton-planting without fallowing, manuring, or growing leguminous crops. This is especially noticeable on negro farms, where the farming is of a very poor class. Under normal conditions Upland cotton never attains the height of Sea Island or Egyptian, and on some of these impoverished soils the plants do not exceed 18 inches, although remarkably well fruited considering the poverty of the soil. In Alabama and Georgia surface mulching is firmly believed in, and in dry weather the fields are treated with the mule cultivator once a week when possible, the general practice being the drier the weather the more frequent the mulching. In some parts of Georgia and Alabama there is no rain for sixty to eighty days

in the months of June, July and August, and the Upland cotton is kept alive by repeated mulching.

During the tour through the States of Georgia and Alabama few crops were seen which would yield 400 lb. of lint per acre, and many crops which would give under 125 lb. This is a great contrast to the Delta of Egypt, where 500 lb. of lint or five cantars of seed cotton is considered an average crop. Texas cotton is inferior to Georgia and Alabama cotton, and especially that produced in South-West Texas, which is distinctly inferior to North and Central Texas cotton.

It is interesting to notice the superiority of the Upland cotton produced on the east of the Mississippi to that grown on the west. This is specially remarkable, as *Gossypium hirsutum* (the Upland cotton plant) is indigenous to Mexico, and not to the east of the Mississippi. The cause of the marked inferiority of South Texas cotton is generally attributed to the high temperature; the same effect is seen in the provinces of Upper Egypt, where Delta cotton degenerates, producing harsher and more brittle fibre.

Texas requires a storm-proof, early-maturing cotton. There is much wind at the time of harvest, and unless the variety is storm-proof, much of the crop is lost by falling from the open bolls. Earliness is also necessary, as all late cotton in Texas is destroyed by the cotton boll-weevil. The best variety is "Triumph," which is a short-stapled Upland cotton of good quality, gives large yields, and is early-maturing and storm-proof. At one time, "King" cotton was extensively grown in Texas, but this variety has been largely superseded by "Triumph," which is superior in quality, and yields a much higher percentage of lint to seed. "King" cotton is useful when circumstances prevent early planting, as it matures rapidly; but it should not be grown under ordinary conditions, as the quality of its fibre is low and the percentage of lint frequently under thirty.

Markets, Transport, Labour, etc.—The chief ports for marketing Upland cotton are Galveston and New Orleans. When in New Orleans, several days were spent at the "Cotton Exchange," where, in conversation with many prominent factors and cultivators of this crop, it was surprising to find that a very

small amount of attention is paid in classification to quality of fibre, the grade being fixed entirely on a basis of colour and freedom from broken leaves or dirt. Much of the late-harvested cotton is greatly damaged by frost-stain, which gives the fibre a characteristic rust colour, thereby reducing its value by at least 50 per cent.

The cultivators in the United States consider the second picking superior to the first, as the first picking always contains a larger percentage of sand and soil, the result of rain "splutter-ing" the lower bolls. In Egypt, and where cotton is grown under irrigation, the first picking is always considered the best, as the cotton does not suffer this damage.

The system of handling Upland cotton in America is disgraceful; the bale-coverings are of the cheapest material and quite inadequate to protect the fibre or hold it together. The amount of loss in transit from the farm to the spinner must in many cases exceed 3 per cent. of the original weight of the bale. The compress sheds, docks, and railway sheds are simply littered with cotton, and it is stated that many of the cotton factors pay their office expenses from the samples they draw and the cotton collected from the floors of their compress sheds and docks. The farmers are largely responsible for this loss, as they refuse to pay for better bale-covering. The same thing would probably exist in Egypt if the fellahin baled their own cotton instead of selling it unginned to the ginning firms, who supply bags for the seed-cotton and bale the product with a good cover after it has been ginned. The advantage of this system of handling the crop lies principally in the cotton bale not being opened until it reaches the spinner, whereas, in America, bales are cut open, sampled and compressed, passing through many hands before reaching their final destination.

The scarcity of labour is the most serious question connected with cotton cultivation in the United States, and in the last twelve years the cost has increased by 50 per cent. It is extremely difficult in many districts to obtain adult male black labour at a dollar per day as a minimum.

During late years railway work has commanded much of the labour of the country, and the ordinary farmer is unable to pay from 6*s.* 3*d.* to 8*s.* 4*d.* per day with board and lodging, which is

the common rate on railway construction work. Many of the farmers are hoping that matters will be adjusted when this class of work is completed, but there is much work in lumbering and also in towns which will employ all available labour for many years to come. When the men are getting such high wages the women and children refuse to work on the land. This cripples the cotton industry, making farmers unable to harvest their crops before the frost comes, which injures much of the fibre by discolouring it. There is no suitable machinery for picking cotton, and success in cotton cultivation in any country is to a large extent dependent on the efficiency and cost of hand labour.

Picking costs 3*s.* 1½*d.* per 100 lb. of seed-cotton on an average or approximately £2 6*s.* per bale of 500 lb. of fibre (1,450 to 1,500 lb. of seed-cotton yield 500 lb. of fibre).

There are considerable expenses connected with handling cotton from the time of harvest until it is sold. The following calculation will show approximately the cost of picking, transporting and marketing a 500-lb. bale of cotton grown 200 miles from any of the large ports, such as Savannah, New Orleans or Galveston.

	£	*s.*	*d.*
Picking 1,500 lb. seed-cotton	2	6	10½
Transport from farm to gin	0	4	2
Ginning	0	4	2
Railway transport, 200 miles at 20 cents per 100 lbs. per 100 miles	0	8	4
Factoring and insurance	0	6	3
Total	3	9	9½

If the value of the bale is considered as £10 8*s.* 4*d.* (5*d.* per lb.), the above shows that the handling of the crop costs the American farmer 33½ per cent. of the gross value of his cotton, the cost of picking alone representing fully 22 per cent. of its gross value.

It is impossible to make the same complete calculation for cotton grown in Egypt, as the Egyptian farmer sells his crop at the farm as seed-cotton to the ginner, who bears the cost of transport and ginning. The following calculation will show the

percentage cost of labour to gross value in the operation of picking.

Picking 1,500 lb. seed cotton at 1½ millimes per lb. = 2850 mill. = £2 6*s.* 10½*d.*

Thus the actual cost of picking is the same as in the United States, but it is well to remember that an average picker in America gathers 100 lb. of seed-cotton daily, whereas in Egypt 60 lb. is an average. The difference is explained by the larger size of Upland cotton bolls, which are more easily picked than Egyptian. Americans endorse this statement, as experimental plots of Egyptian cotton cost the Agricultural Department 2*s.* 1*d.* per 100 lb. more to pick, and even then the pickers complained about the difficulty of pulling the fibre from the bolls.

The average value of Egyptian cotton is 8½*d.* per lb. and supposing, for the sake of comparison, it was made into 500-lb. bales, these would have a gross value of £17 14*s.* 2*d.*; therefore the picking represents 13 per cent. of the gross value, instead of 22 per cent. as is the case with American Upland.

There is a more marked difference in many of the other operations on the farm, as the American negro receives from 4*s.* 2*d.* to 8*s.* 4*d.* daily, and the Egyptian fellah only from 10*d.* to 1*s.* 5*d.* The Egyptian fellah is the superior worker, being more persevering and industrious.

Cotton Seed.—At the present time cotton seed is in great demand, and finds a ready market at the ginneries, which are principally worked by oil-millers. Many of the farmers exchange their cotton seed for cotton meal, as the meal is more readily available as a manure. The usual exchange in the South is 2,000 lb. (American ton) of seed for 1,200 lb. of meal; others sell the seed at an average of £3 2*s.* 6*d.* per American ton. Cattle are scarce in the cotton belt on the east of the Mississippi, but are plentiful in Texas and the west, where large areas are still devoted to cattle-ranching. The cotton-farmer never thinks of fattening cattle, but many of the oil and ginning firms are fully alive to the profit in cattle-fattening, and it is a common sight in the west to see the mills surrounded with yards where cattle are fattened exclusively on a mixture of cotton meal and hulls. Hulls are sometimes purchased as horse-food at £1 0*s.* 10*d.* per ton.

The cotton belt would yield a much larger cotton crop if there was more mixed farming to supply organic manure to the land. The exclusive use of artificial manures cannot result in the same fine physical soil conditions as is produced by the application of organic manures.

II. *Long-stapled.*

It is only within the last few years that long-stapled Upland cottons have been cultivated. The crop is almost exclusively grown in the valley of the Mississippi, on the rich river bottom lands. The Mississippi valley is the richest part of the cotton belt, and large yields are obtained without manuring and with but little cultivation. Long-stapled cotton is more delicate than ordinary Upland, and gives much smaller crops, although the fibre is distinctly superior in length, being over 1 inch.

Small quantities of long-stapled Upland are grown in South Carolina and Georgia, but the area is decreasing in those States; in fact, throughout the cotton belt the tendency is to give up the cultivation of long-stapled Upland, and even in the Mississippi valley it is estimated that the area at present devoted to these varieties is only about one-fifth of that of last year. The cause of this decrease of long-stapled Upland cultivation principally lies in the fact that the supply has exceeded the demand for this staple, and the present premium of 2 cents per lb. is not sufficient to compensate for the smaller crop produced by these varieties when compared with ordinary Upland. Two years ago the premium was as high as 7 cents, and it is considered that when the premium is under 4 cent a pound it does not pay to cultivate this class of cotton.

There is little prospect of the production of long-stapled cottons increasing in the United States, as they are late in maturing, and this is becoming the most important factor in American cotton cultivation, since all late cotton in affected areas is destroyed by the "cotton boll-weevil." It is the general opinion of American cotton experts that all varieties of long-stapled Upland cottons are allied to, or derived from, "Allen's Long Staple," two of the best varieties being "Griffin" and "Queen." In the United States all long-stapled Upland cottons are spoken of as "Florodora cottons."

C.—EGYPTIAN COTTON.

During the past two years an average of fifty-four million pounds of this staple has been imported yearly from Egypt, and in 1907 the value of these imports exceeded all previous records, and amounted to over £3,300,000. The average price in the Boston markets was about 11*d.* per lb., or double the price of ordinary Upland.

In view of the considerable value of this import, the Department of Agriculture has been endeavouring to produce Egyptian cotton in the United States to supply their home market. The standard Egyptian varieties have been experimented with, but the experiments have been a total failure throughout the main cotton belt extending from Carolina to Texas. The chief cause of failure is that there is insufficient heat to mature the plants before frost sets in. Experiments have met with more success in the south-west, and especially in the Colorado River region of Arizona, where the deep alluvial soils, irrigation and a longer and warmer summer approach more closely to the ideal conditions of the Egyptian Delta.

In 1902 all experiments in the main cotton belt were abandoned, and experiments at Yuma in Arizona and Calixico in California were commenced, Yuma being the chief centre of experiment.

During the first three years these experiments were practically a failure, but after five years of acclimatisation and selection great improvement was effected, and now the Department hope to grow Egyptian cotton for their own use, although they will never produce it in large quantities. The fibre produced in Arizona is considered to be wanting in colour, lustre and evenness of staple, but is of good length and strength. The Department have had great difficulty in keeping it from crossing with Upland cotton, and they therefore discourage the growth of the latter in the neighbourhood of the experiments. It is unlikely that American-grown Egyptian cotton will ever compete with Egyptian proper, as the loss of lustre and colour reduces its value for mercerising, a process to which Egyptian cotton is specially adapted. The American experiments are interesting, as they clearly demonstrate the value of acclimatisation, and

show that poor results obtained in early trials with a new variety do not necessarily indicate that this variety is hopelessly unsuitable for introduction.

SOME DISEASES AND PESTS.

Cotton suffers much more from diseases and insects in the United States than in Egypt. The diseases on the east of the Mississippi differ to a remarkable degree from those on the west, and two good examples are those of the "Wilt Fungus" of the east and the "Root Rot Fungus" of the west.

Wilt Fungus (Neocosmospora vasinfecta).—This fungus enters the roots from the soil, working its way into the vascular system of the plant, and ultimately killing it by preventing the ascent of the sap. The fungus seems to be able to exist as a saprophyte, as there are cases on record where seven years' rest failed to free the land from "wilt." Fungicides have no practical effect, and the only method of control is to grow resistant varieties which have been produced by selecting healthy plants from an infected area. Disease resistant selection has been successfully accomplished in the Sea Islands, where "wilt" disease threatened to extinguish the industry. The experiments were conducted on the plantation of Mr. Rivers, James Island, by the Department of Agriculture, Washington. At the time of the visit to this plantation, less than 1 per cent. of the plants were affected with "wilt" disease, although many of the surrounding plantations had over 25 per cent. of the crop destroyed by it.

Root Rot Fungus (Ozonium omnivorum).—This disease is indigenous to Texas, and there is little hope of its extermination, as no cotton is able to resist it. The root rot attacks lucerne as well as cotton, and frequently destroys 25 per cent. of the crop even when grown for the first time on virgin soil. The disease generally manifests itself when the crop has reached the period of maturation, and is characterised by rapid decay of the root and that part of the stem which is covered by soil. It is easily distinguished from the "wilt" as the stem above the ground is never discoloured, the disease never spreading into the vascular tissue of the stem, as in the case of the wilt disease of the eastern section of the cotton belt. Crops growing on clay and

heavy alluvia always suffer most, the disease being favoured to a large extent by anaerobic conditions. Deep winter cultivation and soil aëration are the most effective remedies, and have been known to reduce the disease from 95 per cent. of the total crop to 5 per cent. It is estimated that 7 per cent. of the cotton grown in Texas is destroyed by this disease.

Anthracnose (Colletotrichum gossypii).—This is a disease found throughout all the cotton fields of America, affecting the bolls and rotting them when they are practically mature. The severity of the disease varies according to season, being most active when there is much rain and little sunshine. The lower bolls always suffer most, and a close-planted crop, beset with weeds, is more liable to injury than a wide-planted crop. The disease causes most damage in the rich river-bottom lands of Texas and Mississippi, but is less injurious on the red clays of Georgia and Alabama. The principal remedies are rotation, drainage, and wide planting.

Cotton Boll-weevil (Anthonomus grandis).—The cotton boll-weevil is the greatest pest of the cotton belt. It was first noticed in the State of Texas in the year 1894, and since then has travelled northward and eastward at the rate of fifty miles a year. In 1906, when it reached the west bank of the Mississippi, it was thought that the river would prevent its onward march, but now in 1908 it is forty miles over the river on the east side, and strongly established in the State of Mississippi. It is calculated that seven years hence it will be in every State of the cotton belt from Texas to the Atlantic.

Should the boll-weevil reach the Sea Island cotton, it will do more harm than it does to Upland cotton, as it is much more severe on the more delicate varieties. It is even probable that the weevil may exterminate the Sea Island cotton industry, and that most of the island farmers will turn their attention to the cultivation of early vegetables for the New York market. At the present time "wilt fungus" has caused many of them to grow asparagus instead of cotton, and market gardening on the islands is a growing industry.

One large landowner in Texas, who lets his land to negro tenants and takes part of the crop for rent, informed me that in 1904 three thousand bales were produced on his estate, whereas,

in 1907, after the weevil reached the district, three hundred bales was the total output. The cotton boll-weevil has done much to stimulate the Southern farmer and lead him to improve his methods of cultivation. It is probable that this will result in the introduction of mixed farming and rotations, and prevent continuous cotton-growing, which has exhausted much of the best soil. It is of the greatest importance that every possible precaution should be taken to prevent the introduction of the boll-weevil into Africa.

GENERAL NOTES.

Parliamentary Report on the Imperial Institute.—A report on the work of the Imperial Institute during 1906 and 1907 has been issued by the Colonial office and presented to Parliament—Annual Series (Cd. 3729–48). An account is given of the work of the several Departments of the Institute, including summaries of the results of the principal investigations conducted for Sierra Leone, Gold Coast, Gambia, S. Nigeria, N. Nigeria, St. Helena, Cape of Good Hope, Natal, Orange River Colony, Transvaal, Rhodesia, Nyasaland, Uganda, British East Africa, Sudan, Somaliland, Seychelles, Mauritius, India, Ceylon, Straits Settlements and Federated Malay States, Hong Kong, Tasmania, S. Australia, W. Australia, Queensland, New Zealand, Falkland Islands, Fiji, British West Indies, British Honduras, British Guiana, Bahamas, Bermuda, Canada, Cyprus, etc.

Fruit from British Columbia.—An exhibition of the chief varieties of apples grown in British Columbia was held at the Imperial Institute under the auspices of the British Columbia Development Syndicate, from Tuesday, December 15, to Friday, December 18. The exhibition was opened by Lord Strathcona and Mount Royal.

Agriculture in Asia Minor.—In Professor Dunstan's recent "Report on Agriculture in Asia Minor, with special reference to Cotton Cultivation" (Cd. 4324), the present cotton output of the Vilayet of Adana (p. 12) is printed as 500,000 bales. This should be 50,000 bales.

Wattle Bark.—In a previous number of this *Bulletin* (1908, **6.** 157) a detailed account was given of the present position of the wattle bark industry. To that information the following details, published since the date of the former article, may be added.

The export of wattle bark from Natal increased from 15,000 tons in 1906, to 23,700 tons in 1907. As a portion of the 1906 crop had to be

left through want of rain, the increase is not quite so great as it appears to be. The value of the bark exported increased from £89,443 in 1906 to about £136,000 in 1907.

Experiments have been made recently with a view to determining the effect on the value of wattle bark of the various "weathering" conditions to which it is subjected (*Natal Agricultural Journal*, 1908, **11**. 480). It has been found that serious consequences follow wetting of the bark immediately after stripping, the tannin-content being considerably reduced. Bark dried in sheds appears to be slightly superior to that dried in the open, even when the latter has not been allowed to become damp.

The question of the conversion of wattle bark into extract before export from Natal is still under discussion in the colony (*ibid.*, 395). The advantages of this course were alluded to in the previous article. In some quarters doubt is expressed as to whether the saving in freight will cover the cost of extraction in the case of wattle bark, and as to whether wattle extract could compete with extracts made from quebracho and similar materials.

It is stated by the Conservator of Forests in the Transvaal (*Trans. Agric. Journ*, 1908, **6**. 439) that the three chief wattles under cultivation there are—*Acacia decurrens*, var. *dealbata* ("silver wattle"); *Acacia decurrens*, var. *mollissima* ("black wattle"); *Acacia decurrens*, var. *normalis* ("green wattle").

Only the black and green wattles are regarded as suitable for cultivation for the production of bark, and it is stated that the latter, which is grown in the South African colonies to a very limited extent, is in reality the more suitable of the two, since it is more resistant to frost, has a cleaner and straighter stem, and reproduces itself very readily from seed. A single analysis quoted shows that the barks from the two species as grown in the Transvaal, contain about the same amount of tannin.

In an article in the *Indian Forester* (1908, **34**. 10) it is pointed out that two Australian wattles, *Acacia decurrens*, Willd., and *Acacia dealbata*, Link, have now been thoroughly acclimatised on the Nilghiri hills of Southern India, and yield considerable quantities of tanning material for local use. Apart from the species of Acacia usually called wattles, there are about eighteen members of this genus indigenous to India, and of these only *Acacia arabica* and *Acacia catechu* are extensively used as sources of tanning materials. It is suggested that attention should be given in India to the cultivation and investigation of the following species of Acacia, which occur in large quantities, and might prove useful for the same purpose:—*A. Farnesiana*, Willd., *A. ferruginea*, D. C., *A. Jacquemontii*, Benth.; *A. latronum*, Willd.; *A. planifrons*, W. and A.; *A. leucophlœa*, Willd.; *A. modesta*, Wall.; *A. suma*, Kurf.; and *A. sundra*, D. C.

Cultivation of Egyptian Cotton in Sind.—During recent years an attempt has been made by the Bombay Government to establish the

cultivation of Egyptian cotton in the province of Sind and the valley of the Indus. The climatic conditions in this region are said to resemble those of Egypt. The soil is a sandy loam, the atmosphere is clear and dry, and the rainfall is sufficiently limited for the crop. The most important point, however, is the existence of canals which enables a system of irrigation to be carried out, similar to that practised in Egypt.

The experiments were commenced in 1904, on a plot of land on the Hiral Wah canal, in the Thar and Parkar district. Four varieties, Abassi, Mitafifi, Yannovitch and Ashmouni, were planted. The experiments were very successful, and the yields compared favourably with those usually obtained in Egypt. The staple showed some deterioration, which was greatest in the Mitafifi and least in the Yannovitch.

In 1905 an experimental farm was started at Mirpurkhas, and seed was distributed to certain cultivators for trial under the supervision of the Department of Agriculture. The total area planted amounted to 1,000 acres, the whole of which was situated on the Jamrao Canal, in a district measuring 2,000 square miles. The season was somewhat unfavourable, but a yield of approximately 450 bales was obtained. The cotton realised very encouraging prices, eleven bales being sold in Liverpool at 9*d.* per lb., when "good fair" Egyptian was quoted at 10*d.* per lb. The greater part of the crop was purchased by a firm of exporters, the price obtained by the cultivators being $5\frac{1}{2}$*d.* per lb. for Mitafifi, and $7\frac{1}{2}$*d.* per lb. for Abassi.

The area planted with Egyptian cotton in 1906 amounted to 5,098 acres, and consisted, as in former years, of small plots scattered over a very large area. The cotton was received at Mirpurkhas and sold by auction. This system of collection and sale by the Government will be continued until the industry is firmly established. The average yield was probably less than 160 lb. of seed-cotton per acre. This low yield is accounted for by lack of care on the part of some of the cultivators, and the ravages of the boll-worm. The cotton, when not stained by the boll-worm, was equal to the average quality of Egyptian Abassi; it was of good length, but was said to have deteriorated in strength.

During 1907 about 2,000 acres were planted with Abassi seed obtained from the 1906 crop ginned in Sind, and 4,335 acres with Mitafifi seed imported from Egypt. The plants were not attacked to any extent by the boll-worm, but in most cases sufficient care was not exercised in the cultivation, and excessive irrigation was practised. The total crop was probably about 1,800 bales of seed-cotton, each of 400 lb. About fifty-five bales of Abassi and three hundred bales of Mitafifi were sold by auction at Mirpurkhas, and realised satisfactory prices. The chief buyers were the Ahmedabad and Bombay mills, and one or two exporting firms. It was reported that samples were being purchased for export to Japan.

The area planted during the present year is of approximately the same extent as that cultivated in 1907 Fifty-six tons of Abassi and eleven tons of Mitafifi seed have been distributed.

Cotton-growing in Togo.—An account of the efforts made during 1900–02 to develop the cultivation of cotton in Togo has been given in a previous number of the *Bulletin* (1904, **2**. 250). Information with regard to the progress of the industry has been published recently in the *Beihefte zum Tropenpflanzer* (1908, **9**. 142), and is summarised below.

The German Colonial Economic Committee have continued their endeavours to extend cotton-growing among the natives, to effect an improvement in the indigenous varieties of cotton, and to introduce good agricultural methods. An attempt is being made to replace the hoe by the plough, but it is realised that decades must pass before ploughing can become general; the beginnings, however, that have been made at the cotton school at Nuatjä and on the Kpeme plantation are full of promise. The Committee have lately conceived the plan of establishing machine depôts in the tropical colonies, which will incite the natives to adopt modern methods on their own account. It is proposed to encourage the natives by allowing them to purchase agricultural implements of all kinds at half the cost price. The depôt in Togo will probably be located at Lome.

A railway is shortly to be constructed in Togo extending from Lome on the coast to Atakpame, which lies about 150 miles to the north. It is considered that this line will be of immense advantage to the promising cotton industry of the Atakpame, Kpeji and Sokodé-Bassari districts.

The exports of cotton from Togo during the present century have been approximately as follows:—

	1901	1902	1903	1904–5	1905–6	1906–7	1907–8
Tons .	nil	20	32	130	214	301	375 (Estimated.)

The chief centres of production are the Atakpame and Misahöhe districts.

For the year 1908 the Committee guaranteed a price, equivalent to about 3½*d*. per lb., for all ginned cotton purchased in the colony. The cotton crop of 1907 realised on the average about 6·4*d*. per lb., and the seed was sold at an average price of about £5 per ton. The Committee have come to an arrangement with the Ginning Companies, whereby the latter undertake the duty of sorting all the seed-cotton which is brought in according to its origin, and of keeping the different varieties strictly separate. The Companies have also undertaken to provide dry, weather-proof stores for the seed. For these obligations the Committee pay the Companies about 1*s*. 6*d*. per load of 77 lb.

Since the American and native varieties of cotton which have been tested in Togo do not appear well adapted to the northern parts of the Colony, whilst experiments with Indian varieties have given favourable results, the Committee have ordered a ton of seed of various kinds from India for distribution.

The agricultural school at Nuatjä has been attended on the average by ninety-five pupils. The area under cultivation is about 370 acres.

The cotton crop obtained at Nuatjä in 1907 amounted to 50 tons. Cultivation with the ox-plough is being increasingly practised at the school. Experiments have been carried out with the object of obtaining suitable varieties for cultivation in Togo, and a form has been obtained from the coast cotton which gives a much larger yield than the kinds previously tested. This variety gave a crop of 800 lb. of seed-cotton per acre; the plants were then cut back, and in the following year a second crop, amounting to about 530 lb., was obtained. It is hoped that it will be possible next year to supply this seed to the northern parts of Togo. Experiments have also been made with the different kinds of "Caravonica" cotton. The Nuatjä school has now been taken over by the German Government, a guarantee having been given to the Colonial Economic Committee that the work of furthering the cotton industry shall be continued.

In order to stimulate cotton-growing in the Sokodé district, an agreement has been entered into by the Imperial Station, Sokodé, the Colonial Economic Committee and the German Togo Company, in accordance with which the Imperial Station appoints carriers at certain markets for the transport of the cotton to the Sokodé ginnery, whilst the cost of transport is borne in equal shares by the Colonial Economic Committee and the German Togo Company. Moreover, the Imperial Station provides warehouses at the markets for the purchase and storage of the cotton and also supplies a shed at Sokodé in which the sorting can be effected. The German Togo Company is under the obligation to send buyers regularly to the markets in the Sokodé District and to purchase the seed-cotton offered by the natives at a price of 1*d.* per lb.

Progress of Agriculture and Forestry in the Sudan.—The following particulars relating to the progress of agriculture and forestry in the Anglo-Egyptian Sudan are taken from reports received from the Secretary to the Central Economic Board of the Sudan Government.

The crop of durra (*Sorghum vulgare*) in the Sobat valley last season was unusually large. Between Gabra and Meheila in Dongola province there are thousands of acres under this crop. It is stated that as a result of last year's bountiful harvest, the beneficial effects of which are already being felt, many of the cultivators will not need to purchase durra for three years.

Attention is also being directed to furthering the export of durra grain. Last autumn a sample of Sudan "Faterita" durra was sold in London at 67 piastres per ardeb (22*s.* 6*d.* per quarter of 480 lb.). Experiments recently made in Hungary show that this variety compares favourably with Hungarian maize as a food for cattle. At present Sudan durra realises upwards of 70 piastres per ardeb at Trieste.

In Sennar province, the area planted with simsim (sesame) has increased largely, and an application for permission to erect a steam crushing mill for this seed has been received. It is stated that this crop is being cultivated in Berber province under artificial irrigation, with a view

to exporting the seed to Marseilles, which is the chief European market for the product. Considerable quantities of the seed have been sent of late to Jiddah on the Red Sea, where there is a good demand for "white grain simsim."

In Berber province cultivators are being recommended to grow as much wheat as possible, in view of the high prices ruling for this grain in Egypt and the Sudan. With a view to selecting a good strain of wheat for cultivation in the Sudan, arrangements are being made to carry out milling and baking tests of the different varieties at present cultivated.

A small consignment of two tons of native castor-oil seed is being collected for despatch to England for commercial trial. In addition, varieties of castor seed from India and Java have been obtained for experimental plantation, and have been distributed to Experimental Farms, etc., for this purpose.

A number of grape vines have been planted experimentally in Dongola province, and are now in promising condition, many bearing bunches of grapes.

In Sennar province arrangements are being made to carry out experiments in tapping, in order to improve the output of gum. A sample of the product from Jebel Guli has been valued (June 3, 1908) at 65 piastres per cantar, franco, equivalent to 1·6*d.* per lb., Omdurman seller paying royalty. The Director of Woods and Forests estimates the area of talh forest in Sennar province at some 3,000 square miles. At present but little gum is obtained thence; but it is hoped that in course of time the output will be increased, thus enabling a cheap gum to be placed on the market.

The Director of Woods and Forests has found in Southern Kordofan, near Jebel Debri and southwards, the gum-yielding tree, *Sterculia tomentosa*, which is allied to the "tartar" (*Sterculia cinerea*) of Roseires and Gallabat districts. The latter tree is sufficiently abundant in the mixed forests of the Upper Blue Nile to make it advisable to investigate the manner of obtaining a supply of the gum, which apparently is not obtainable from healthy trees. It will be necessary to make an enumeration survey, and to ascertain how many trees can be treated without reducing the stock and output. The following trees are also reported as growing in Southern Kordofan—African bdellium, *Balsamodendron africanum*, which yields a myrrh substitute; and the elephant tree, *Boswellia papyrifera*, from which a "frankincense" is obtainable.

Excretion of Toxic Subtances by the Roots of Plants.—In a recent number of the *Memoirs of the Department of Agriculture in India* (1908, ii. No. 3), Mr. F. Fletcher, Deputy Director of Agriculture for Bombay, has published the results of some researches on this subject.

These were commenced some years ago in Egypt, where it was observed that cotton plants among which grass grew as a weed were in poor condition, and did not revive on the application of manures. Their

poor condition was not due to lack of moisture or to the appropriation of the necessary food material by the grass, and the only explanation appeared to be the excretion of some substance by the grass which was toxic to the cotton plants.

Further investigations have been made in India by means of field experiments and water cultures. The former consisted mainly of observations on the crop-yields of sorghum, pigeon pea, sesame, etc., when grown in close proximity to (1) fallow land, (2) other crops, and (3) plants of the same species. Without giving details of the results of these experiments, it may be said that the following conclusions have been arrived at: (1) All plants excrete a substance which is toxic, both to themselves and to other species. (2) The quantity of toxic material excreted by the different crops varies, when reckoned per unit area of a field sown in the ordinary way. (3) Sensibility to the excreted substance varies with the plant.

It appears from the results so far obtained that the excreted substance may be an alkaloid, but further experiments are being made with a view to ascertaining its exact nature. It is precipitated by tannin and by certain mineral salts, which may explain the beneficial action mineral fertilisers and certain leaves containing tannin (e. g. *Terminalia* sp., etc., used in the Kanara district) have upon the crops.

The bearing of the question on the rotation of crops is evident, since each crop by its excretion fouls the soil for the same crop whose roots would occupy the same layer of soil.

An Insect Pest of Wheat.—In a pamphlet published by the Government of Cyprus under the title of *Treatise on the Œcophora of Wheat*, the Director of Agriculture, M. D. Saracomenos, has reported on an important insect pest affecting the wheat crop of the island. The pest *Œcophora temperatella* has been known in Cyprus since 1889, but it has remained for the author to elucidate its life-history completely, and to suggest means of proved efficacy for its extermination. The perfect insect of *Œcophora temperatella*—a butterfly—appears in April and lives from eight to twelve days. The eggs laid by the imago hatch out in ten days, and the grubs immediately seek shelter, where they remain quiescent until December or January. By this time the cereals have commenced active growth, and the caterpillars, which are $\frac{3}{4}$ mm. long and of no greater diameter than a hair, climb up the plant and bore into the leaf, opening up a gallery between the upper and lower epidermises, which, however, are not ruptured. The grub lives for three and a half months in the leaf-tissue, at the expense of which it greatly increases in size. The leaves now become discoloured and withered when they are deserted by the pest for fresh leaves, the process greatly reducing the vitality of the plant. When development is complete, however, the grubs leave the host plant and burrow into the ground, where they assume the chrysalis form. The perfect insect emerges some fifteen days later. There is but one life-cycle per year.

The author has carried out successful experiments with regard to combating the pest. Three lines of action are recommended, viz.: (1) careful ploughing with European ploughs before sowing: the field weeds form an important harbour for the grubs, and the native plough is quite ineffective for the turning over and pulverisation of the soil, which is so useful in weed eradication. (2) Grazing of sheep or goats upon a crop of Œcophora-infected wheat: the further growth induced is practically free from the grubs. (3) Burning of the stubble. The report is illustrated with several original photographs and drawings.

RECENT REPORTS FROM AGRICULTURAL AND TECHNICAL DEPARTMENTS IN THE COLONIES AND INDIA.

In this Section of the Bulletin a Summary is given of the Chief Contents of general interest, of Reports and other publications received from Agricultural and Technical Departments, in the Colonies and India.

CYPRUS.

Annual Report of the Director of Agriculture, 1907–8.—Mention is made of the trials made with a new type of plough, designed by the Department of Agriculture, and which appears to have commended itself to the Cypriote farmers. A short account is given of the results of cultivation trials with "Allen's longstaple," "Peterkin," "Griffin's" and "Sea Island" cottons, both in the irrigated and non-irrigated districts. In the former the best results were obtained with the first and fourth of the varieties mentioned above, the yields from these being much better than from the native kinds, although the imported sorts were sown later in the season than is desirable. This late sowing was specially disadvantageous to the "Peterkin" variety. In the non-irrigated area, owing to heavy floods, sowing was late, but the yields obtained from the first, third and fourth of the varieties mentioned were nearly identical. These experiments are being continued and other American varieties are also being tried. The quantity of origanum oil distilled last year was 1,766 lb., a slight decrease on the previous year's output, owing to delay in commencing distillation. It is expected that a larger output of the oil will be secured in future years.

ANGLO-EGYPTIAN SUDAN.

Central Economic Board, Secretary's Report for 1907.—The Central Economic Board was constituted by an order of the Sudan Government in 1906 to "consider, investigate and report upon such questions as

may be referred to it by the Governor-General of the Sudan, or initiated by individual members." The Board, which is purely consultative in function, consists of the Heads of the various Government departments concerned with agriculture, forestry, irrigation, education, etc. The present Report, which is the first issued, was originally prepared for departmental use only, but it was eventually decided to issue it to the public, and to include in it the trade returns for the year 1907. This decision is commendable, since the Report contains much useful information regarding the economic resources of the Sudan, and its publication should stimulate interest in the country on the part of merchants and traders.

Gum arabic, forming the principal article exported, has naturally attracted much attention during the year, and various improvements have been effected with a view to improving the collection, transport, and storage of gum; ranging from the licensing of gum brokers to the sinking of new wells in Kordofan, to enable collectors to go further afield. Experimental planting of gum trees has also been undertaken in Sennar province, and fresh villages of gum collectors are being founded. Attention is being directed to meeting the wishes of European and American gum consumers who wish large supplies of a cleaner gum than ordinary Sudan "sorts," and an experimental gum cleaning machine has been erected at Omdurman.

It is satisfactory to find that in 1906–7, for the first time since the reconquest of the Sudan, the durra crop (*Sorghum vulgare*) was largely in excess of the needs of the population, and in certain districts the crop was even left to rot on the ground. In these circumstances a foreign market is being sought for the grain, and it seems likely that this may be found at Aden, which serves as a distributing centre to various markets, and possibly also at Jiddah and along the Arabian coast. A proposal to use durra starch as a source of alcohol is also under consideration. Castor, sesame, and other oil seeds are receiving attention, and attempts are being made to encourage the expression of oil from these seeds in hand oil-mills for local use. In November 1907 a small supply of Sudan rubber was sold in London at an average price of 5*s*. 3*d*. per lb. Experiments made by the Forest Department show that *Landolphia owariensis* does not bear transplanting, and in future it is proposed to sow direct in the forests. Para rubber trees are stated to be giving promising results, but Castilloa has been unsuccessful. It is proposed to try experiments with *Ficus elastica*, *Funtumia elastica*, and with "Guayule." The pearl-fishery investigations in the Red Sea are being continued, and there appears to be good prospects of creating a new industry in this direction.

The statistical tables show that the total imports into the Sudan in 1907 were valued at £E.1,604,137, and the total exports at £E.449,329. Some of the most important items of export were:—ivory (£E.40,304), ostrich feathers (£E.7,676), skins and leathers (£E.12,375), animals and animal alimentary produce (£E.25,015), horns and bones

(£.E.3842), wheat (£E.5,602), durra (£E.24,412), cotton seed (£E.7,179), sesame seed (£E.19,734), dates (£E.20,860), gum (£E.154,592), coffee (£E.3,531), senna leaves (£E.5,932), salt (£E.1,326), cotton (£E.44,002), and seed cotton (£E.52,007).

RHODESIA.

Agricultural Journal, 1908, **5**. No. 6.—Cattle-breeding in Mashona land—The "velvet bean" in Rhodesia (recommends the cultivation of this plant as a winter foodstuff for cattle—Experiments with grasses and forage crops at the Government experiment station at Salisbury—Results of mealie trials at the Government experimental station at Salisbury—Manurial experiments in maize-growing at Premier estate, Umtali—Notes on tobacco culture (points out that the world's tobacco consumption is about 2,000,000,000 lb. per annum, and that about one-fifth of this is of the Turkish and bright Virginian types, the cultivation of which is being especially encouraged in Rhodesia)—Vegetable fibres for Rhodesia—Aloe fibre decorticator.

TRANSVAAL.

Annual Report of the Department of Agriculture, 1906–7. Contains reports on the work of the Department during the year, by the Director, and on the results achieved in the several branches of investigation carried on, by the officers in charge of these. In the section of Agrostology and Botany reference is made to experiments on the feeding-value and stock-carrying capacity of the veld, which are in progress, and to work on the eradication of poisonous plants and noxious weeds. The forest section is devoting attention to the developments of forests by the formation of nurseries, the distribution of seed, and by grants for tree-planting. The entomological division was largely occupied with work on the destruction of locusts, the success of which may be judged by the fact that 12,137 swarms were destroyed at a cost of £9,479, the value of the crops saved being estimated at £102,260. In the tobacco division seed selection experiments are being conducted at various stations with the object of securing strains possessing the characters required by manufacturers. Attention is being paid especially to the production of "Boer," "bright" leaf, cigarette and cigar tobaccos. The establishment in Pretoria of a central warehouse where tobacco could be purchased from farmers and then sorted, fermented, graded, and baled, is under consideration. In this way greater uniformity in the various sorts of tobacco produced could be secured.

First Report of the Committee appointed to advise the Government in regard to the Best Method of developing the Tobacco Industry of the Transvaal.—The title of this Report sufficiently indicates its scope. After taking evidence from parties interested and consulting expert advisers, the committee conclude that large areas of the colony are suited for tobacco cultivation, and that by taking advantage of differences in soil

and climate, several types of leaf may be produced. There is already a considerable import both of unmanufactured and manufactured tobacco, and consequently there would appear to be a reasonable probability of locally produced tobacco selling readily, provided that the right types are grown. The recommendations for economic work made, are that the work of the Department of Agriculture on tobacco should be extended by the organisation of a training station, the formation of experiment stations at Zoutpansberg and Piet Retief, the engagement of planters with practical experience in tobacco-growing for teaching purposes, the institution of central warehouses for preparing, grading, and baling tobacco, and the distribution of improved seed.

Mines Department—Report on a Reconnaissance of the N.W. Zoutpansberg District.—The area reported on lies between Pietersburg and the Limpopo river, the northern boundary of the Transvaal.

Diamonds are found at Seta and other localities, in ancient gravels to the east of Rhodes' drift on the Limpopo. Still further east, cupriferous veins in crystalline schists are worked at the Messina mine, near the confluence of the Zand river with the Limpopo. At M'Tamba camp, to the south, veins of copper ore are met with in the Waterberg System. In the same neighbourhood coal is found in the Karroo System. The salt pan (Zoutpan) to the north of the east end of the Zoutpansberg is also described.

NATAL.

Agricultural Journal, 1908, **10**. No. 7: Another phase of the bark (wattle bark) situation—Analyses of wattle trees (the results show that the bark, leaves and wood of one year old wattle trees contain 17·7, 6·89, and 3·90 per cent. of tannin respectively)—Locust destruction (report on work done in 1907–8)—The forests of Europe, how they are conserved—The oversea wattle bark market (a *résumé* of information obtained in Europe regarding the relative positions of Australian and Natal wattle barks)—Laboratory notes (analyses of beets grown during the past season, fibre from *Pavonia columella*, etc.). 1908, **10**. No. 8: Agricultural co-operation—Acetylene plant residues—Wattle bark *versus* extract (contains information supplied by two firms of tanners in the United Kingdom indicating that in this country the demand for the extract is likely to increase)—The forests of Europe, how they are conserved—Caustic soda and sulphur dip (discusses the effect of this dip for sheep on the quality of the wool produced)—Agricultural co-operation in Cape Colony during 1907—Intensive cultivation and its profits—South African locust bureau (report on proceedings of annual conference held in Durban on August 10th). 1908, **10**. No. 9: Phosphates in Natal (a description, with analyses, of the phosphate deposits discovered recently at Bray Hill, Mooi river)—Natal mineral phosphates (analyses of samples from deposits at Weenen)—The stalk-grub and cut-worm—Forests of Asia—Blood manure (analyses of this manure as produced in Natal are given)—Cape fruit

industry—Progress of agriculture (an address to the Royal Society of Canada, by Dr. Saunders)—Fibre machinery (a description of the Prieto machines)—Division of agriculture and forestry (administration report for 1907–8).

CAPE OF GOOD HOPE.

Report of the Department of Agriculture, 1907—*Report of the Superintendent of Agricultural Co-operation for the eight months ending December* 31, 1907.—The first of these publications contains summaries of work done in each of the principal branches controlled by the Department, viz. veterinary science, entomology, agriculture proper, horticulture, viticulture and chemistry. The Agricultural Assistant states that great interest has been manifested during the year in fibre crops, such as cotton, flax, hemp, ramie, etc., and that both cotton and flax experiments have given promising results, the former especially in the south-eastern coastal districts and near Vryburg, and the latter in the Western Province, though the plant is at present being grown mainly for seed, and it remains to be seen whether the fibre can be extracted profitably. Turkish tobacco is being cultivated experimentally at French Hoek, with good results, and it is thought that a certain regular output of this tobacco may now be looked for from that district. In the section contributed by the Senior Analyst reference is made to the resumption of work on the systematic examination of the soils of the colony, and a brief summary of the results of the first part of this investigation is given. Some attention is being given to the cultivation of the castor-oil plant; and samples of the seed of *R. sanguineus*, *R. minor*, *R. zanzibarensis* and *R. major*, grown in the colony, yielded 46·2, 41·9, 39·9 and 36·0 per cent. of oil respectively. Analyses of gold, copper and manganese ores from various parts of the colony are quoted, and there is a brief reference to the alleged occurrence of platinum-bearing rocks in the Eastern Province. The investigation of this matter was not finished at the date of completing this Report, but no platinum had been found in any of the samples examined so far (compare this *Bulletin*, 1908, **6**. 312).

Agricultural Journal.—1908, **33**. No. 2: Agricultural soils of Cape Colony (continued from previous issues)—Woolly aphis (records results of experiments with tobacco extract in spraying for the destruction of this apple pest)—Destruction of mountain vegetation (discusses the effect of this on the agricultural condition of the valleys)—Bee pirates (describes the habits of certain "digger wasps" which prey on hive bees, and suggests remedial measures against them). 1908, **33**. No. 3: Notes (including one on the 'tsammá, or "Kalahari melon," which appears to be used largely in the Kalahari desert as a source of water)—Arable farming—The agricultural soils of Cape Colony—Tuberculosis in animals and its relation to public health—Analyses of colonial oats—(tables of results of analyses of various kinds of oats grown in different

parts of the colony)—Descriptions of some common Cape fungi—Notes on the possibilities of farming with cattle in the Stutterheim and neighbouring districts—The "dip" controversy (a *résumé* of experiments intended to determine whether or not the application of "lime and sulphur" dip to sheep injuriously affects the quality of the wool.

Geological Commission, Twelth Annual Report, for 1907—*Geological Survey of Parts of Vryburg, Kuruman, Hay and Gordonia.*—This includes the southernmost portion of the Kalahari desert, from Vryburg west to the German frontier and southwest to the Orange river, an area largely covered by sand. Representatives of most of the old non-fossiliferous formations are met with, including the Kheis Series; the Kraaipan Series, resembling the Swaziland Series, see Annual Report for 1905, p. 215; rocks provisionally referred to as the Wilgenhout Drift Series; the Vaal River (Ventersdorp) System; the Transvaal (Potchefstroom or Griqualand) System, and the Matsap Series, which has been correlated with the Waterberg System. Rocks belonging to the Karroo System also occur, as well as ancient granites and later intrusives. A blue ground pipe similar to those in which diamonds are found is also described.

Geological Survey of Portions of Mafeking and Vryburg.—Most of the area is occupied by superficial deposits consisting of sand, sandstone with siliceous cement and calcareous tufa which is sometimes more or less silicified. The formations comprise the Kraaipan Series, the Transvaal System and granite with inclusions of crystalline schists.

Geological Survey of Portions of Hopetown, Britstown, Prieska and Hay.—This area extends on either side of the Orange river, between the towns of Prieska, Griqua Town and Hopetown. Ancient granite and crystalline schists are exposed on the Vaal river; the Transvaal and Karroo systems are also represented, as well as intrusive rocks of different ages and blue ground pipes and fissures, in which diamonds are found at Sand Drift in the Hay division, not far from Prieska.

INDIA.

Report of the Imperial Department of Agriculture, 1905–6, 1906–7.—The first part of this publication, containing the report of the Inspector-General of Agriculture in India, gives a short summary of the present organisation of agricultural investigation in the Indian Empire. There is, first of all, the Imperial Department of Agriculture, with eighteen appointments including specialists in agriculture, chemistry, botany, entomology, mycology and bacteriology. In addition an Agricultural Department has been organised in each province with a nucleus staff, consisting usually of the principal of the agricultural college, a chemist, a botanist, and one or more agriculturists. Altogether there are now in connection with the Imperial and Provincial Departments, fifty-six appointments.

Considerable progress has been made in the organisation of the

Agricultural Research Institute at Pusa, of which five sections, viz. agriculture, chemistry, botany, entomology and mycology are already in operation, the bacteriological section still remaining to be opened.

The Report contains a series of reports by the heads of the various sections. In the chemical section 657 samples were examined in 1905–6 and 749 in 1906–7. These were mainly soils, feeding stuffs, sugars, sugar canes, and oil seeds. A systematic investigation into the formation of cyanogenetic glucosides in such plants as sorghum and linseed is being carried on, and it has been established that the same "variety" may produce much or little glucoside depending on the conditions under which it is grown.

The report of the Imperial mycologist deals with the investigations carried on during the two years on fungoid diseases of palms, sugar canes, coconut, mangoes, etc. In the agricultural section special attention appears to have been paid to cotton, and experiments on jute, flax and sugar-cane cultivation have also been carried on.

The Report concludes with a list of nearly two hundred papers, memoirs, etc., published by the staff of the Imperial and other agricultural departments of India during the two years.

Memoirs of the Department of Agriculture in India (*Entomological series*).—1908, **2**. No. 3: The red cotton bug (*Dysdercus singulatus*, Fabr.). 1908, **2**, No. 4: The Castor semi-looper. 1908, **2**. No. 5: The tobacco caterpillar (*Prodenia littoralis*).

Agricultural Journal, 1908, **3**. No. 3.—Chenab canal colony—Fourth annual meeting of the Board of Agriculture (gives *inter alia* a *résumé* of investigations in progress)—A few points regarding the conservation of soil moisture—Cassava as a famine food (details the methods by which cassava has been popularised as a foodstuff in Travancore)—Leaf manuring in South Canara—Imported insect pests—Artificial fertilisers for cotton—Improvement of cattle in Bengal.

Bulletin of the Department of Agriculture, Madras, No. 58.—The cultivation of ground nuts (a *résumé* of information on this subject, dealing with climate, rainfall, soil, treatment of land, etc., required by the crop).

Quarterly Journal of the Department of Agriculture, Bengal, 1908, **2**. No. 1.—Cultivation of tobacco in Bengal—Guinea grass—Scientific work on indigo in 1907–8—Value of Indian cattle manure and its proper management—Cultivation of plantain—How to make cheap silk—Protection of grains from insects—Breeds of cattle in the Darjeeling district—Notes on the common cattle diseases of Bengal—Effect of breed and food on milk—Lac and lac industries—Notes on sugar, jute, and flax in Bihar, depth at which to sow wheat, eri cocoons, etc.

Annual Report of the Government Cinchona Plantation and Factory, in Bengal, for the Year 1907–8. The total number of cinchona trees in the permanent plantations on the 31st of March, 1908, was 3,471,216, of which 2,779,746 were *C. Ledgeriana*, 346,699 hybrid No. 1, 92,992 hybrid No. 2, and 251,779 *C. succirubra*, being a total decrease of 227,561 trees

since last year. Propagation of hybrid No. 2 has been continued, and the stock has risen from 1,200 to 6,820. The whole of these have been transplanted to Munsong, in anticipation of new land for cinchona cultivation being allotted there. The harvest of bark was 445,638 lb., of which 419,388 lb., 407 lb., 21,914 lb., and 3,929 lb. were derived from *C. Ledgeriana*, *C. succirubra*, hybrid No. 1 and hybrid No. 2 respectively. The quantity of bark worked up in the factory was 945,900 lb., yielding 27,564 lb. of quinine sulphate—an increase on the previous year's output of 11,499 lb., due in part to the new machinery installed recently, and in part to the use of new processes. The average yield of quinine sulphate from the bark was only 2·90 per cent., but as the stock of old and poor bark has now been worked up, much better yields are expected in future years. The quinine sulphate and "cinchona febrifuge" are disposed of mainly to the various depôts of the Indian Medical Service, provincial dispensaries, jails, and by sale in pice packets to the general public. The net profit on the year's working was slightly over 44,127 rupees.

Annual Report of the Industrial Section of the Indian Museum, 1907–8. This contains a summary of work done in the chemical laboratory attached to the museum, and lists of additions made to the economic, art-ware, and ethnological courts during the year.

Indian Trade Journal.—1908, **10.** No. 123: The camphor war (discusses the competition between natural and synthetic camphor, and refers particularly to the possibility of Indian turpentine oil being used in the preparation of synthetic camphor). 1908, **10.** 124: The sugar and paper industries (deals with the proposal to use "megass" from sugar mills, as a paper-making material)—Lime brick manufacture in India (describes the process of making lime bricks and gives details of cost of an installation of the necessary plant). 1908, **10.** 127: Industries for India (points out that cheap sulphuric acid is essential in a large number of manufacturing industries for which India possesses stores of raw materials, and suggests the extension of sulphuric acid production in the country). 1908, **10.** 130: Sulphuric acid (commenting on the article published in the Journal for September 3rd (see above), Professor Cunningham states that already sulphuric acid can be put on the market in India at a lower rate than the imported article, and that even this price could be lowered if freight rates permitted the use of the excellent pyrite deposits in Chota Nagpur and the Central Provinces). —Commercial possibilities of tapioca (advocates the cultivation of cassava as a famine food and as a possible article of export)—Fusion method of salt manufacture—Purification of coconut oil. 1908, **11.** 131: Some Calcutta industries (refers to (1) the working of the kaolin deposits at Mangalhat, recently taken in hand, the material being used for the manufacture of cups and saucers, galipots, insulators, etc., under the supervision of Japanese experts, and (2) the manufacture of buttons from bones). 1908, **11.** 132: Iron and steel in the United Provinces (a review of Mr. Dobb's monograph on iron and steel work in the

United Provinces of Agra and Oudh)—Artificial silk manufacture (it is stated that the present production of the various kinds of artificial silk is as follows: nitro-cellulose process, 2,645,000 to 3,300,000; cupro-ammoniacal process, 2,200,000 to 2,645,000 lb.; viscose process, 880,000 to 1,100,000 lb.; France produces 1,100,000 to 1,240,000 lb. of the three kinds. It is also mentioned that a factory using the Thiele process has been started at Yarmouth for the manufacture of artificial silk)—Mines and minerals in Baluchistan (deals with the production of coal and petroleum, and refers briefly to the occurrence of asbestos, clays, lead ores, etc., at present unworked)—Industries of Chittagong (mentions tea culture and the fisheries of the district)—"Caffeineless coffee" (a reference to a recent German patent for removing caffeine from coffee without impairing the flavour of the latter). 1908, **11**. 133: Another industry for India (advocates cocoa cultivation)—Coffee substitutes (a catalogue of plant products used as coffee substitutes)—Arts and manufactures of Baluchistan (refers *inter alia* to the manufacture of salt from various salt worts).

Report of the Chief Inspector of Mines in India for the Year ending 31st December, 1907.—This report relates to the mines in British India only. It does not include, moreover, the ruby mines in Burmah owned by natives, or any quarries less than 20 feet deep. Statistics are given of the production of coal, mica, manganese, gems, gold, limestone, tin and chromite. There are copper mines in the Central Provinces, but they are not at present in the producing stage. Particulars are also furnished of accidents. These now include explosions from firedamp, which is found to increase in amount with the depth.

Records of the Geological Survey of India, 1908, **36**. Part 3.—Several papers on the miocene fossils and strata of Upper Burmah. The prospects of oil in the Taungtha hills are stated to be poor. Note on fossils from Oman, Arabia, of Permo-carboniferous, Triassic and Jurassic or Cretaceous age.

The rubies of the Kachin Hills, Upper Burmah, are ascribed, by Dr. A. G. Bleeck of Munich, to the contact metamorphism of a magnesia-limestone under great pressure.

CEYLON.

Tropical Agriculturist, 1908, **32**. No. 2.—Rice cultivation in Ceylon—Planting of the new species of Manihot (mentions that one hundred plants of *M. dichotoma* are now growing in the gardens at Peradeniya, but that seed will not be available for a few years)—The village cultivator and paddy cultivation (suggests the formation of water-storage tanks to facilitate the cultivation of rice in the drier regions)—Mangoes in Ceylon (illustrated)—New nitrogen fertilisers—Literature of economic botany and agriculture, xxxii. (a continuation of the bibliography, this section dealing with the genera Castilloa, Cryptostegia, Funtumia, Hancornia and Hevea)—Notes and queries—Correspondence

—Progress report of the Ceylon Agricultural Society, etc. *Supplement*, Rubber shipments (suggests that in view of the increase in exports from Ceylon, and the Federated Malay States, and the prospects of great increases in the near future, further rubber planting should not be undertaken)—Rubber and tea—Correspondence relating to the coco-nut stem disease—The tobacco industry of the Northern Province (the report of a committee appointed to consider the crisis, which has arisen owing to the failure of the Indian market for the coarse chewing tobacco grown in this province; the committee suggests that the 30,000 rupees required for experimental work in improving the type of tobacco grown should be provided by the Government). 1908, **32**. No. 3: Selected edible Garcinia fruits (an illustrated descriptive account of the "mangosteen" and the "Goraka" and "Cochin Goraka" fruits). Pineaple culture (from *Bulletin* No. 83 of Florida Agricultural Experiment Station)—Some other ornamental trees (refers to several timber trees introduced into Ceylon, such as "marsh mahogany" (*Swietenia mahogani*), etc.—*Passiflora fœtida* (suggested as a covering for the ground to keep down weeds, especially "lalang" or "illuk" grass)—Literature of economic botany and agriculture, xxxiii. (this section gives a bibliography of diseases affecting *Hevea brasiliensis*). *Supplement*, The future of rubber—Native agriculture and tillage—Rubber in the Sandwich Islands (from the *Annual Report of the Hawaii Agricultural Experiment Station*, 1907)—Tapioca cultivation (from the *Straits Times;* a description of the method of cultivating cassava, and the methods and machinery used in its conversion into tapioca).

STRAIT SETTLEMENTS AND FEDERATED MALAY STATES.

Agricultural Bulletin, 1908, **7**. No. 9.—Weeding in Para rubber cultivation (asserts that the policy, at present generally followed in Para rubber cultivation, of carefully weeding the plantation is disadvantageous, since it involves heavy expense and leaves the upper layer of soil in a loose condition in which it can be readily washed away by heavy rain; in forming new plantations it is suggested that the clearing should first be grown with a selected green manure, and the rubber trees planted in this)—Rate of growth of forest trees in the Federated Malay States. "Getah gerip" (*Willughbeia firma*) from Pulau jerajah. 1908, **7**. No. 10: Improvement of fruits in Malaya (gives a list of the native and introduced fruits, and suggestions for their better cultivation)—The improvement of the dairy cow in the Malay Peninsula (suggests the introduction of English cattle for breeding purposes)—Notes on some piscicides (describes some of the common Malay fish poisons)—The Chinese method of rotation of crops, and reclamation of "lalang" land.

Selangor Government Gazette, *Supplement*, Sept. 11, 1908.—Contains the Resident-General's annual report (1907). During the year the Government Geologist in the course of field work at Bukit Argas

was shown a rock consisting of quartz, felspar, and muscovite mica, and which on examination proved to contain gold. Scheelite (an ore of tungsten) has been found near the Raub mines. The Director of Agriculture reports that the area under rubber at the end of 1907 was 126,235 acres, of which 61,552 acres was in Selangor, 46,167 acres in Perak, 17,656 in Negri Sembilan, and 860 in Pahang. The area under the coco-nut palm increased by 7 per cent., and there was also a small increase of that under coffee. Experiments on the destruction of "lalang" grass and other weeds, by spraying with sodium arsenite solution, were made during the year, and attention was also given to tapping experiments on rubber trees, experimental camphor cultivation and the improvement of native fruits. The Institute of Medical Research is conducting an investigation into the alleged causation of beri-beri by rice, the clinical portion of the work being carried on by an officer of the School of Tropical Medicine, and the chemical part, viz. the examination of the rice for toxic constituents, by the chemist to the Institute. The report states that there is now a considerable body of evidence in support of the view that Siamese rice causes beri-beri.

HONG KONG.

Report on the Botanical and Forestry Department for 1907.—Mentions *inter alia* that after three years' trial the conclusion has been reached that cotton cultivation is a failure in the Hong Kong district, and that only crops giving a high return are likely to do well there. As evidence of the interest being taken in many British colonies and elsewhere in camphor cultivation, it is stated that large quantities of seed of the camphor tree have been collected and distributed during the year. In addition to Yenping, mentioned in last year's Report as a place where the cultivation of *Aleurites cordata* was regularly carried on, it is recorded that this tree also occurs in the hills near How Lik, eighteen miles above Sam Shui.

AUSTRALIA.

Western Australia.

Journal of the Department of Agriculture, 1908, **17**. Pt. 1.—Agricultural industries on the gold fields—Antidote for poisoned stock (gives a number of reports from farmers who have used with success the special antidote, to the "York Road poison" plant, issued by the Department)—Examination of horses at shows—Sheep yards, shearing shed and dip—The rabbit-proof fence—Western Australian apples in London—Root rot—Nangeenum State farm—Chapman experimental farm—Experiments with "African wonder" and "Rhodes" grasses—Phosphate deposits of Christmas Island—Wood distillation (records the installation of wood distillation plant at Gippsland)—The fruit fly parasite.

Report of the Department of Mines for the year 1907.—The chief mineral substances produced are gold, copper, tin, coal and silver.

There was a substantial increase in the amount of copper, and a slight increase in that of tin. In all other cases there is a decrease. No tantalite was raised on account of the absence of any demand. Reports from the State Mining Engineer, the Metallurgist and Engineer on State Batteries, Engineer for Mines Water Supply, Government Geologist, Director of the School of Mines, Chief Inspector of Machinery and Chief Inspector of Explosives and Government Analyst. Full mining statistics are appended.

Queensland.

Agricultural Journal, 1908, **21**. No. 2: Prickly pear as fodder, (deprecates the recommendation of prickly pear as a fodder plant on the ground (1) of its low nutrition value, and (2) the desirability of graziers not relaxing their efforts to eradicate this pest from their land)—Change of seeds—Destruction of charlock—State farms (a description of a visit to the State farms at Hermitage, near Warwick, and at Westbrook)—A new hybrid orange, "Beauty of Matavi" (regarded as a cross between the "mandarin" and "pomelo")—Principles of pruning (refers especially to peaches and nectarines)—Strawberry growing—The cultivation of rubber for tropical Australia (deals with the tapping of Para rubber trees)—"Poling" of Furcræa suckers—Plants poisonous to stock (deals with the wallflower poison bush (*Gastrolobium grandiflorum*) and gives results of a chemical examination, indicating that this plant contains a poisonous alkaloid similar to that found in the closely related "York Road poison bush" by Messrs. Mann and Ince). 1908, **21**. No. 3: Australasian wool markets—The selection of phosphates—Agricultural college and State farms exhibits at the exhibition at Bowen Park, with illustrations of some of the chief exhibits—Angora goats (a short monograph on the management and breeding of these animals)—Judging breeds of cattle—Milk trade—Prickly pear and rabbits—Plants suitable for outdoor culture (lilies, etc.)—Sericulture (a short monograph on the rearing of silkworms)—Two "Prickly pear" affections, a description of "dry rot" and "sleeping sickness" as affecting "prickly pears"—Artesian water (the artesian water of Queensland is alkaline and therefore detrimental to plants irrigated by it, and this article deals with a proposal to add to the water small quantities of nitric acid in order to render it suitable for irrigation purposes).

Geological Survey of Queensland. Publication, No. 198: Gold, platinum, tinstone and monazite in the beach sands on the South Coast, Queensland, with appendices on the beach sands of New South Wales, and on the physical properties, sources and uses of platinum. This contains details of methods of working beach deposits. *Publication*, No. 203: Graphite in Queensland, with special reference to the Mount Bopple graphite deposits. These deposits, which are formed by the action of intrusive igneous rocks on coal of the Burrum coal measures of Triassic age, are situated close to the North Coast Railway between Gympie and Maryborough, about 26° south latitude. See this *Bulletin*

(1907, **5**. 79). Graphite has also been found under similar circumstances in the Mackay District about latitude 21° south, and Cape Upstart 19° 44′ south. A deposit of graphite and graphitic shale more than 22 feet thick and containing from 20 to 40 per cent. of carbon has been found at Hampden, near Cloncurry, in the interior of the State, about 21° S. and 141° E. Graphite also occurs in the Stanthorpe district in the south-east of the State and other localities. *Publication*, No. 204: The West Moreton (Ipswich) coalfield, with special reference to the Bundamba district. This coalfield lies west of Brisbane. The deposits, which are of Jura-Trias age, furnish the greater part of the Queensland output, about half a million tons, and the Bundamba district supplies over three-fourths of the coal from the field. It affords steam coal. To the westward is another important district lying immediately north of Ipswich, which furnishes all the coke manufactured on the field, and still further to the west highly gaseous coals are found at Walloon, Rosewood and Purga.

The Bundamba beds overlie the Ipswich beds conformably, and the Walloon beds are believed to occupy a still higher horizon. A detailed account of the separate seams and their geological relations is given. There is a general map embracing the different districts on a scale of one inch to a mile, and a larger map of the Bundamba district on a scale of eight inches to a mile. *Publication*, No. 207: Some mines in the Burnett district, west of Maryborough. These are copper, gold and bismuth mines. *Publication*, No. 208: Report on the Norton goldfield. This goldfield, situated in the Gladstone district about 24° S., affords lode stuff containing not only gold, but ores of zinc, lead and copper, as well as pyrites and mispickel. There is also a little silver. Various methods of dealing with these ores are suggested, including pyritic smelting, and separation by gravitational and electro-magnetic methods.

Annual Report of the Under-secretary for Mines for the year 1907.—This volume includes a general survey of the mining industry of the State, the reports of the Wardens of the different mining districts, the Inspectors of mines and the Government Geologists. Among the metals and minerals dealt with are antimony, asbestos, bismuth, chromite, cinnabar, coal, copper, gold, graphite, ironstone, lead, limestone, manganese, mineral oil, molybdenite, opal, sapphires, silver and lead, scheelite, tin and wolfram.

Government Mining Journal, 1908, **9**. July: The Etheridge goldfield—Stanhills tinfield, near Croydon—Queensland coal industry. 1908, **9**. August: Notes—The economy of winning ore—A new primary electric battery—Minerals at the Brisbane exhibition.

Victoria.

Journal of the Department of Agriculture, 1908, **6**. No. 8: The breeding, selection and care of the dairy cow—Fruit tree stocks—Fourth progress report on viticulture in Europe (the Malaga district)—The

proclaimed plants of Victoria, "stinking mayweed"—A suggestion for weed suppression (prizes are offered to children bringing in the largest numbers of specified weeds to the schools, where the weeds are destroyed)—Insect pests in foreign lands (a progress report by a special commissioner charged with the investigation of insect pests in Europe) —A farm in the making—Merino rams. 1908, **6**. No. 9: Parasitic skin diseases of animals—Elements of animal physiology, xii. the circulation—An effective lime spreader—Results of analysis of samples of artificial manures collected in Victoria—Garden notes; the tulip—Insect pests in foreign lands (seventh progress report of the special commissioner appointed to investigate this subject)—Citron melons—Effect of "pollarding" oak-trees—Eradication of bracken—Proclaimed plants of Victoria; "pitch weed"—Fifth progress report on viticulture in Europe—Maize for fodder—Potato experimental fields, 1907-8—Effects of manure on potato crops—Lamb mortality through tetanus.

Records of the Geological Survey of Victoria, Vol. 2, *Part* 4.—A large number of short reports on mines and mineral localities in which gold, copper, antimony, tin, turquoise and coal have been found. Others deal with the geological boundaries in the Woori Yallock basin, and those between the head waters of the Acheron and Yea rivers and the Yarra; the mineral resources of east Gippsland which include gold, silver, copper, lead, tin, iron, marble and barytes; obsidian "buttons," and fossils of various ages.

New South Wales.

Annual Report of the Technological Museum for 1906.—This gives a list of the more important additions made to the museum during the year, an account of the museum exhibit of New South Wales products sent to the New Zealand international exhibition, and a list of papers, mainly on botanical subjects, contributed by the Curator alone, or in association with the assistant Curator, to scientific societies.

Agricultural Gazette, 1908, **19**. No. 8: Artesian irrigation (suggests the use of nitric acid on soils which have become alkaline as the result of irrigation with artesian water, and discusses methods by which nitric acid could be made cheaply in Australia on a large scale for agricultural purposes)—Practical notes on forestry, suitable for New South Wales, xviii. oaks—Feeding of pigs—The incubator at work—Diseases of fowls—Science in agriculture (a *résumé* of information on soil bacteria —Progress report by the commissioner appointed jointly by several of the Australian States to study the means of destroying the fruit fly, codling moth and other fruit pests—Mummy wheat—"Goats rue" (*Galega officinalis*) and *Chloris divaricata* (both of these are suggested as forage plants). 1908, **19**. No. 9: Wheat growing (1) on the table lands; (2) in the New England district (advocating improved methods of culture with the object of increasing the yield of wheat per acre)—Some practical notes on forestry, suitable for New South Wales, xviii. oaks—

Sheep at Bathurst experimental farm—Diseases of fowls, Parts xi., xii.—Hawkesbury agricultural college and experimental farm (gives a series of estimates prepared by the staff of the college of the cost of producing crops in the Hawkesbury district)—Stock ensilage—Importation of live-stock into the Philippines (a reprint of the order relating to such importation)—Eradication of weeds—Drying apricots and peaches (a description of the methods and apparatus in use for this purpose)—Rust in fruit crops (deals with the "rust" of peaches and remedial measures for this)—Rib grass or plantain (advocating this as a useful fodder)—Lectures on the meat industry (referring to the proposal to establish systematic instruction in this industry at the East of Scotland Agricultural College, Edinburgh)—Export of grapes to England (a report on a consignment of grapes recently exported to the United Kingdom for sale in London)—Apple report (an account of trade during the past apple season in London)—Progress report from the Commissioner investigating "fruit fly" and "codling moth" pests on behalf of the Governments of New South Wales, Victoria and South Australia (this report deals with Asia Minor, Cyprus, Egypt, India and Ceylon).

Department of Mines and Agriculture (*Mineral Resources Bulletin*, No. 12), being a report on the Drake gold and copper field.

The formations described consist of volcanic and intrusive igneous rocks and Permo-carbonaceous beds. The reefs are narrow but numerous; they will require economical metallurgical processes as the richer secondary ores are now exhausted. The field is near the north boundary of the State. There is a map on a scale of three miles to eight inches.

Memoirs of the Geological Survey (*Geology Bulletin*, No. 6), on the geology and mineral resources of the Western Coalfield.

An historical and descriptive account of the area, which includes the Blue Mountains, and its stratigraphy and palæontology, embracing Devonian, Permo-carboniferous, Trias, Tertiary and recent strata. Igneous rocks of various ages. Economic products:—coal, kerosene shale, limestone, fire-brick and pottery clays and building stones. The maps are on a scale of one inch to two miles.

South Australia.

Record of Mines. (*Fourth edition.*)—A short but useful description of the geology of the State; a reprint of *Mines and Mining Companies in South Australia*, extracted from a local almanack for 1848. This contains an interesting reference to "a vein of auriferous gossan" from which gold to an amount not exceeding twenty-four ounces had been obtained. This antedates the discovery of gold in New South Wales and Victoria.

There is a brief account of every mine in the State, classified under the headings—copper; silver-lead; gold; iron; mineral phosphates; brown coal, lignite, etc.; manganese; miscellaneous; gems and rare

minerals. The last heading includes monazite, found in river sands and containing about 6 per cent. of thoria.

Lists of localities for economic minerals and a map showing the approximate area occupied by metalliferous rocks are also furnished.

Tasmania.

Geological Survey Bulletin, No. 3, on the Mount Farrell Mining-field. —The physiography and geology of the district—The lead, copper and iron ores and their mode of occurrence—Detailed descriptions of mining properties.

NEW ZEALAND.

Museum Bulletin, No. 2.—Fishing and sea foods of the ancient Maori.

Department of Agriculture. Division of Biology and Horticulture. Bulletin, No. 7.—*Diseases and Insect pests of the potato.*—A new edition of a pamphlet issued in 1905, when "Irish blight" and other potato diseases became prevalent in the Colony. In this edition descriptions of common insect pests of the potato and remedial measures against these are given.

Annual Report of the Dominion Laboratory, 1907.—Contains a summary of the analytical work done during the year. This includes analyses of coals and carbonaceous minerals, pottery clays, iron ores, copper ores, scheelites (some of which were very rich in tungstic acid), gold ores and concentrates, lead and zinc ores, waters and manures. A concentrate from Tablelands, Nelson, contained 4 oz. 1 dwt. 22 grains of platinum and 2 oz. 14 dwt. 4 grains of osmium-iridium per ton, whilst one from Appos Flat, Parapara, contained 10 dwt. 2 grains of platinum and 15 grains of osmium-iridium per ton. (*Cf.* this *Bulletin*, 1907, **5**. 93.)

New Zealand Geological Survey (*Bulletin*, No. 5, New Series) on the geology of the Cromwell sub-division, western Otago division.

This *Bulletin* deals with a small mountain area in the southern portion of South Island on either side of the river Clutha and to the east of Lake Wakatipu. After describing the physical characters of the region a brief account of the geology is given. The formations include the Maniototo series consisting of crystalline schists which are believed not to be older than Carboniferous or Devonian; the Kakanui series, another crystalline series which, it is suggested, is of upper Carboniferous age; lacustrine beds of Pliocene age containing lignite, Pleistocene (glacial) and recent deposits. Gold is obtained from alluvium and from lodes.

A description is given of the "blowing-down" system of working auriferous alluvial deposits in which the gravel is washed down from above instead of from below. Lodes of antimony ore are met with, but have not yet been worked successfully.

The lignite, though so recent in age, has been largely used for local purposes, especially for raising steam on gold dredges. The Pliocene beds in which it is met with have been considerably affected by earth movements.

West Indies.

Imperial Department of Agriculture. Pamphlet series, No. 54.—Fungus diseases of cacao, and sanitation of cacao orchards. A monograph issued for the use of planters.

Canada.

Report of the Bureau of Mines, Ontario, 1907, **16**. Part 2: The cobalt-nickel arsenides and silver deposits of Temiskaming. (Third edition.) The second edition was reviewed in this *Bulletin* (1906, **4**. 371). The present edition embodies the details of recent discoveries and developments.

GENERAL COLONIAL AND INDIAN PUBLICATIONS.

In the following paragraphs a summary is given of the more important contents of the chief Colonial and Indian periodical publications received recently at the Imperial Institute, in so far as these relate to economic products and are likely to be of general interest.

Malta.

Colonial Report, Annual [Cd. 3724-35].—It is mentioned that the area under cotton shows a slight increase, the figures for the past two years being 670 acres in 1906-7 as compared with 871 acres in 1907-8. The export of lint was 116,079 lb., valued at £2,628, of which 111,655 lb. went to the United Kingdom. The average yield was 245 lb. per acre, and the price ranged from 5½*d.* to 7*d.* per lb., which, it is stated, is insufficient to induce any extensive cultivation in the islands.

Nyasaland.

Colonial Report, Annual [Cd. 3729-38].—Mentions that the exports of tobacco during 1907-8 amounted to 554,395 lb. as against 413,316 lb. in 1906-7, and that trade in this product with the United Kingdom has been commenced, a British company having established a buying factory at Blantyre at which tobacco is sorted, graded and packed. A crop of 400 tons is expected in the present year.

The cultivation of tea is confined to the Mlanje district, where 516 acres are at present under this product. The crop in 1907-8 amounted to 2·5 tons, and 9·5 tons are expected in the present year. Plantations of rubber, mainly Ceara, have been formed in almost every district

of the Highlands. During the year 1,119 lb. of plantation rubber was exported as against 972 lb. in 1906–7 and 532 lb. in 1905–6. Wild rubber was exported to the extent of 15,533 lb., valued at £3,301. Ginger is being extensively propagated and about 2,000 plants, raised originally from two received in 1901 from Kew, are growing in the experimental gardens, and of these about 1,000 will be available for distribution this year.

There was a diminution in the export of cotton in 1907–8 as compared with the two previous years, due to unfavourable weather. Egyptian cotton is grown in the Shire river districts and on Lake Nyasa, but this variety is liable to fungoid diseases, with the result that the yield of cotton per acre is frequently reduced in Nyasaland from 147 lb. to 60 or 70 lb. In the Highlands, American cotton is chiefly grown, and attention is being devoted to increasing the yield, which is at present 120 to 130 lb. per acre on the average. Cotton growing is also being encouraged among the natives, and 17 tons of seed have been distributed to them this season, so that a large increase in the production of native-grown cotton is expected.

Many planters are experimenting with fibre-yielding plants such as Mauritius hemp and sisal hemp, 30,000 sisal plants having been distributed by the Botanical Department during the year. Experiments made with ramie cultivation have not given good results so far.

Cape of Good Hope.

Colonial Report, Miscellaneous [Cd. 4323]—*Report on the Rietfontein area.*—A report by the assistant resident magistrate dealing with the physical features, climate, vegetation, people, fauna and avifauna and industries, chiefly stock-raising, of this area, which includes the Kalahari desert.

Gold Coast Colony.

Colonial Report, Annual [Cd. 3729–37].—The total value of the exports for the year 1907 was £2,641,674, an increase of £645,462 on the previous year, the increase being mainly due to larger exports of gold dust, cocoa, timber, palm kernels, kola nuts and copal. There was a decrease in the value of rubber exported, partly owing to a fall in prices and partly owing to the greater attention being given to cocoa. The exports of cotton also diminished, due, it is stated, to the completion of the Togoland railway, so that cotton from Togoland is no longer exported by way of the Volta river (compare p. 420).

A new botanical station has been opened at Asuanchi, for the Central Province, and a large area of land was cleared during the year and planted with cocoa and rubber. Dr. Graham of the West African Medical Staff has investigated the biting insects of Ashanti during the year and has also paid some attention to the insect pests affecting cocoa. The report concludes with a list of economic investigations conducted for the Colony at the Imperial Institute during the year.

Government Gazette, 1908, No. 85.—Contains the report of the Commission appointed to inquire into the timber industry of the Colony.

NORTHERN NIGERIA.

Government Gazette, 1908, **9**. No. 8.—Contains a report by the forestry officer on a tour through the Ankpa district, Bassa Province, from which it appears that the "Illorin balsam tree," *Daniella thurifera*, and the "shea nut tree" are commonly distributed along the route followed. The principal crops grown are cassava, millet, Guinea corn, yams and ground nuts, and between Bagana and Akwucha, a small amount of cotton. Numerous long narrow belts of forest containing mahogany, ebony and other useful timber trees were observed.

INDIA.

Indian Agriculturist, 1908, **33**. No. 8: Mosquitoes and "millions" (a letter from the Commissioner of Fisheries in Bengal mentioning a confirmation of the fact recorded in a previous letter that the small Bengal fish "Techokhe" destroys mosquito larvæ)—Jute forecast—Iron and steel industries of the Punjab—Carpet industry—Cotton-seed oil mills for India—The Madura hand-loom weaving factory—Irrigation in Sind. 1908, **33**. No. 9: The industrial survey of Bengal—An agricultural college for Bengal—The Indian coal industry for 1907—The new college of agriculture (an account of the opening ceremony of the Bengal Agricultural College at Sabour)—The industries of Bengal (reprints from the *Calcutta Gazette* of portions of two reports dealing with the present positions of (1) "technical education"; (2) "industrial position and prospects of Bengal"—Indian cotton mill industry, progress in 1907—Scope for cotton manufacture in India—Pests and disease in Indian agriculture (from the *Madras Mail*).

Indian Forester, 1908, **34**. No. 9: Danger of the formation of pure forests in India (pointing out the risks attaching to the spread of fungoid and insect pests in forests composed of only one species)—The aims and future of forest research in India—The forests around Darjeeling—A plea for so-called "worthless" species—Some plantations in the Satara district of Bombay—Correspondence, including letters on the "Cultivation of lac in the forests of Sind," "sal" resin, etc. Reviews, translations, etc. 1908, **34**. No. 10: Effects of forests on rainfall—The use of *Terminalia arjuna* bark for tanning (descriptions of the method of collecting the bark and the method of using it in native tanning are given)—Correspondence on forestry matters—Reviews and translations—Cause and effect of the gradual disappearance of forests on the earth's surface—Shikar, travel and natural history notes—Extracts from official papers on forestry—Indian wattle bark (giving details of the distribution of Acacia species in India from *Capital*)—Market reports, etc.

FIJI.

Colonial Report, Annual [Cd. 3729-44].—Reference is made to the establishment in the Colony in 1905 of a Department of Agriculture, having two experimental stations, one at Nasinu and the other at Lautoka. At the former experiments are being made in the cultivation of rubber, cocoa, coffee, cloves, pepper, cinnamon, nutmegs, fibres and bananas. At the Lautoka station the chief crop was "sea island" cotton, but maize, rice, pea nuts, sisal hemp, etc., are also being experimented with. It is pointed out that cultivation trials indicate that the Para rubber tree can be grown successfully and that large areas of suitable land are available.

WEST INDIES.

St. Vincent—Colonial Report, Annual [Cd. 3729-41].—Mentions that the yield of "sea island" cotton for export amounted to 338,833 lb. as against 225,632 lb. exported last year. The yield did not quite come up to expectations, as 3,200 acres were under this crop in place of only 1,534 acres in the previous year.

St. Lucia—Colonial Report, Annual [Cd. 3729-43].—The sections of this report dealing with "manufacture and fisheries" and with "agricultural industries" show that since 1903 there has been a considerable fall in the export of rum from the island, viz. from 16,286 to 3,652 gallons. The molasses formerly employed as a source of rum is, however, now largely exported in the form of cattle food. Efforts have been made to induce planters to turn their attention to rubber, but the response so far has been small, and only 2,000 Castilloa plants were asked for by planters from the experiment station during 1907, as against 6,967 in 1906, and there has been no demand for the Para rubber plants raised from seed obtained from Ceylon. The total number of economic plants distributed from the experiment station during the year was 74,644, an increase of nearly 10,000 on the previous year, the chief demand being for limes, of which 105,475 have been sent out during the years 1905-7, in addition to large numbers grown in private nurseries.

Turks and Caicos Islands—Colonial Report, Annual [Cd. 3724-42].—The salt industry was in an unsatisfactory condition, since although the season was a good one for production there was little or no demand, this having been diverted to other sources of supply during the last three years, when, owing to disastrous rains, very little salt was made. The prospects of the sisal hemp industry in the Island are said to be good, high prices for this product having been as a rule realised during the year.

Colonial Report, Miscellaneous [Cd. 4326]—*Report on the salt industry.*—Mention has been made already in this *Bulletin* of the salt manufactured in these islands (1907, **5**. 188) and attention directed to its exceptionally high purity. This report gives (1) a historical *résumé* of

the industry since its commencement in 1678, and (2) a short account of the method of manufacture in "salinas" or "salt ponds" as at present carried on, with interesting details of the cost of manufacture, statistics of production and future prospects of the industry.

CANADA.

Canada's Fertile Northland.—A reprint of the evidence given before a Select Committee of the Senate of Canada during the Parliamentary Session 1906–7, and the report based thereon. The natural resources and agricultural possibilities of those parts of Alberta and Saskatchewan which lie north of the Saskatchewan water-shed, of Ungava, Keewatin and Mackenzie, a total area of 1,637,559 square miles, are dealt with and much information is afforded as to the timber supplies of this region, the crops which can be cultivated, and the present condition of the means of transport.

NOTICES OF RECENT LITERATURE.

NEW BOOKS.

THE FOREST FLORA OF NEW SOUTH WALES. By J. H. Maiden. Published by the Government of the State of New South Wales. (Sydney: William Applegate Gullik, Government Printer.)

The completion of the third volume of this work affords an opportunity of reviewing the separate Parts, which have been published at regular intervals during the last few years. Probably no one is more intimately acquainted with the Australian flora than the author of the volumes under notice, and for many years past he has urged the advisability of a thorough botanical exploration of the State with which he is more especially concerned. The matter has been urged not merely as a scientific desideratum, but also in a full belief that much good would result to the mercantile community and to the country as a whole from a more complete knowledge of its forestry resources. The present work, therefore, owes its existence to a desire to place before the public an account of the principal trees of New South Wales, in the hope that much-needed further knowledge may be gained as a result of stimulation of interest, and as a step towards the final goal of a complete botanical survey. The author has aimed at producing a work which shall be acceptable to the professed botanist and public alike, and a perusal of his pages shows that his efforts have been attended with much success.

Each Part of the work contains descriptions of not less than four species of forest trees, which are well illustrated with from four to six plates according to circumstances. No regular botanical sequence has

been adopted in selecting the species for description, a plan which, on many grounds, is to be deprecated, since, even in a flora admittedly incomplete, a systematic arrangement of the species is of great service in identification; but there can be little doubt that the difficulties arising from publication over an extended period determined the adoption of the present system.

In dealing with the plants an indication of the botanical name and natural order are followed by a technical description. The latter should be intelligible to all who have received a fair botanical training, but in view of the desirability of the work reaching and being used by those who may not have this advantage, it is hoped that a simple, well-edited glossary of botanical terms will appear at the completion of the volumes. The account of the economic value of the timbers and other forest produce, great and small, has received full benefit of the extensive knowledge of the author, and the characteristically numerous references to literature are of great value to all desiring knowledge of the plants and plant products of New South Wales.

It would be impossible to refer to all the interesting plants described in these volumes. Mention may be made, however, of the accounts of the more important species of Eucalyptus, probably the most important economic genus of the Australian flora. Special attention has been given to the description of the Ironbarks, which are regarded as the finest of New South Wales hardwoods. Much confusion exists as to the local names of these Eucalypts, a fact which is certain to militate against the successful export of the timbers, and, in view of this difficulty, the author proposes a simple trade differentiation of the timber based upon botanical characters. It is suggested that Ironbark should be exported under two names only, viz., White Ironbark and Red Ironbark. The former is obtained from the tree most commonly known as White, Grey or She Ironbark (*E. paniculata*); and the latter from two species, the Narrow-leaved Ironbark (*E. crebra*) and the Broad-leaved Ironbark (*E. siderophloia*). Attention, however, is drawn to the fact that the actual colour of the ironbark timber often varies considerably.

The Wattles (*Acacia* spp.) have also been described at considerable length and illustrated with photographs. In certain cases, *e. g. A. pycnantha*, analyses, giving the tannin-content of bark from different parts of the plant and from plants grown under different conditions, are appended. It may be noted that the author's classification of the difficult *Acacia decurrens* group of wattles is the one now generally adopted by botanists and practical bark-growers.

Special notice has been made of other important forest trees. The Turpentine tree (*Syncarpia laurifolia*) is dealt with, the timber of which has long been highly esteemed for its teredo-resisting qualities, and as a second-grade paving material. And among others may be mentioned the Cypress Pines (*Callitris* spp.), certain of which yield Australian Sandarac; the Quandong (*Fusanus acuminatus*), whose fruits make a

palatable preserve; the Queensland Nut (*Macadamia ternifolia*) and the handsome Blackwood (*Acacia melanoxylon*).

SCHLICH'S MANUAL OF FORESTRY. Vol. v., FOREST UTILISATION. By W. R. Fisher, M.A., Cantab. et Oxon. Second edition. Pp. xxii. + 840. (London: Bradbury, Agnew & Co., Ltd., 1908.)

This book forms the last of the series of exhaustive volumes which constitute Dr. Schlich's Manual of Forestry. Essentially it consists of a translation of *Die Forstbenutzung* of Karl Gayer, a book which, since its first edition in 1863, has been recognised as the standard German work on the commercial application of forest products. The later editions of Gayer's work were revised and brought up to date by Dr. Mayr in the ninth edition, and the latter forms the basis of the present English version, which, in its turn, has benefited from the large and varied forestry experience of the translator.

The title of the book would probably convey to the lay mind but a slight idea of the nature and extent of its contents. The author has defined the science of Forest Utilisation as "a systematic arrangement of the most appropriate methods of harvesting, converting and disposing profitably of forest produce in accordance with the results of experience and study," and the scope of the work may be gathered from the terms of this definition.

Forest produce may be divided naturally into two great divisions: the first and by far the most important product, timber; and the less important, but highly valuable minor produce, the nature of which depends entirely upon the character of the forest and the conditions under which it exists. In the first of the three parts into which the book is divided the author deals with the former class of product. The properties of timber from the anatomical, physical, mechanical and chemical standpoints are considered at some length, and probably the most important section of Part I. comprises the chapters dealing with the felling, conversion and transporting of timber. These questions are dealt with in a very practical manner in over 250 pages, and numerous illustrations render the treatment exceptionally clear. The author considers not only the more obvious operations involved, but also discusses, from the German standpoint, the principles underlying such questions as the organisation of forest labour, the management of gangs, and the relative rates of wages of the various classes of workmen employed. The concluding chapter of Part I. is concerned with the more important industrial application of wood, including road-paving, ship-building, harbour works, coopery, mining and general carpentery.

Parts II. and III. deal with the utilisation of minor forest produce. The former is concerned with such produce as is obtained from the trees themselves. Special attention has been given to the methods of harvesting tanning barks, but as the information supplied is based upon German practice only, several important tanning barks receive no more than passing mention. The resin-tapping industry is also treated of at

some length. Attention is called to the enormous extent of the industry in the United States, and to the extraordinarily wasteful methods of collection practised in that country which have hitherto resulted in the destruction of the forests operated upon. As a pleasant contrast the conservative system of tapping adopted in the Landes of Gascony receives full treatment, the methods of tapping being described in detail and the implements employed fully illustrated. Reference is also made to the resin-tapping experiments made in India in the case of *Pinus longifolia*, the turpentine oil of which is now being examined at the Imperial Institute. Part III. further contains an account of the peat industry with descriptions of the machinery used in the digging and preparation of the product.

The book is produced in a style uniform with that of the previous volumes, and is characterised by the same practical and useful type of illustration. Photographic reproductions of aspects of Indian forestry have also been added. It occasions some surprise, however, that a considerable looseness of expression with regard to certain botanical matters should have been allowed to become stereotyped in the second edition of the English translation. Such statements as "gum in the bark is suspended as latex in the sap" are meaningless, and although no claim can be made that our knowledge of the composition of latex is as yet exhaustive, it is sufficiently extensive to render a definition of the fluid as "fats and oils suspended in water" greatly beside the mark. The analysis of Para rubber given on p. 732 appears to be an incomplete analysis of fresh *latex* of *Hevea brasiliensis;* and the wax yielded by certain species of Myricaceæ is generally regarded as being obtained from the exterior of the fruits and not from the bark.

Previous volumes of this work have been reviewed in the *Bulletin of the Imperial Institute*, 1904, **2**. 211; 1905, **3**. 204; and 1907, **5**. 193.

FRUIT TREES AND THEIR ENEMIES. By Spencer Pickering, M.A., F.R.S., and Fred. V. Theobald, M.A. Pp. xxv. + 113. (London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd., 1908.)

This is a useful work by the Director of the Woburn Experimental Fruit Farm, and the Entomologist of the Wye Agricultural College. The authors state that the work was originally intended as a calendar, for the guidance of fruit-growers and gardeners, for the operation of spraying with insecticides and fungicides, but that it has expanded somewhat, and includes also a brief account of the chief fruit pests of this country, as well as the means of destroying them. These additions appear necessary, owing to the fact that there is a tendency among fruit-growers to the rather indiscriminate use of spraying mixtures, through ignorance of the nature of the pests met with and the want of authoritative advice upon the subject. Much information will be found in the book which will enable the more important pests to be readily recognised, and in every case the most suitable known method of combating these is given.

Referring to the insects, some acquaintance with the different changes which they undergo is regarded as essential for their thorough destruction. The insects belonging to the orders whose primary forms feed upon the entire leaves are generally destroyed by poisoning the leaf surfaces, but those which suck only the internal juices through punctures are often indestructible by this method, and are best treated with suffocating or corrosive insecticides. Stress is laid upon the importance of tillage and the necessity for burning prunings and rubbish, and an apparatus designed for the destruction of insects in the flying stage is referred to.

A brief account is given of the method by which fungoid diseases establish and propagate themselves, and attention is directed to the importance of guarding against the dissemination of spores. The difficulties in the way of eradication of fungoid diseases, when once established, are evident when the protective structures of the fungi themselves are examined, and the potency of the two chemical fungicides mentioned constitutes further evidence of these.

A warning is given against the alteration of the proportions of the chemicals recommended for use in making a spraying insecticide, for fear of damage to the trees or failure in efficiency, and the thoroughness of the operation of spraying is insisted upon.

Several pieces of apparatus are mentioned, and, in a chapter entitled "Materials," the methods of preparation of twenty-eight different chemical insecticides and fungicides are detailed.

Under the name of each fruit the chief insect and fungoid pests which attack it are described, and the remedial measures to be employed are stated in each case. The spraying calendar itself will be found most useful for reference, and the book will be valuable in India and the colonies as well as in this country.

LES VÉGÉTAUX UTILES DE L'AFRIQUE TROPICALE FRANÇAISE: Etudes Scientifiques et Agronomiques, publiées sous le patronage de MM. Edmond Perrier et E. Roumé, par M. A. Chevalier. Fasc. II. Le Karité, l'Argan et quelques autres Sapotacées à graines grasses de l'Afrique, par Em. Perrot. Pp. 195, and map. (Paris: A. Challamel, 1907.)

This forms the second part of a series of monographs projected by M. Chevalier, well known as an authority on the economic products of French West Africa, and deals with the products of a number of African Sapotaceous plants. The natural order Sapotaceæ contains several species yielding products of great industrial importance, such as gutta-percha, balata and various fats. The last mentioned are perhaps of first importance only in the countries of their production, though some of them are beginning to acquire considerable interest for manufacturers in Europe and America, notably the Mowra and Illipe butters of the East Indies, and the Shea butter obtained from West Africa. The present monograph is confined to the African Sapotaceæ, yielding

oil-seeds, and consequently more than half of it is devoted to the Karité, or shea butter tree (*Butyrospermum Parkii*). The history of this tree, since its discovery by Mungo Park in 1796, who encountered it on the Upper Senegal, down to the recent observations of Chevalier, is dealt with in detail. From Chevalier's observations it appears that, apart from the typical species, three varieties exist, connected by intermediate forms and distinguished mainly by differences in the leaves. The names and habitats of these varieties are as follows :—

1. *Butyrospermum Parkii*, var. *mangifolium* (Pierre and Chev.). From the Upper Senegal and Middle Niger to the Chari valley.

2. *B. Parkii*, var. *Poissoni* (Chev.). Dahomey, Gold Coast, and Ivory Coast.

3. *B. Parkii*, var. *niloticum* (Kotschy and Chev.). Bahr-el-Ghazal in the Anglo-Egyptian Sudan.

In later chapters the distribution of the tree in West Africa, its products, the preparation of shea butter from the kernels of the fruits, the composition of the butter, and the so-called "shea gutta" are all dealt with. Finally a chapter is devoted to discussing the necessity of protecting shea trees in West Africa, and the formation of plantations is advocated, possibly in association with *Landolphia Heudelotii*.

The Argan (*Argania sideroxylon*) has long been known as occurring in Morocco, where the limpid oil extracted from its seeds plays almost as important a part in the dietary of the people as does olive oil in that of the peoples of Southern Europe. In this volume the history of the tree is traced, and an account is given of its botany and of the characters of the oil obtained from it, to which M. Gentil has again recently directed attention in his *Exploration au Maroc* (Paris, 1906). The exportation of this oil from Morocco, it should be noted, is forbidden by decree of the Sultan.

In the last portion of the book brief reference is made to the D'jave or "Noumgou" (*Mimusops Djave*), the kernels of which yield a fat somewhat resembling shea butter, the "Moabi" or "Maniki" (*Mimusops Pierreana*) and the "false Mowra" and "false Illipe" of the Congo, whose precise botanical origins are not yet known.

The volume is well illustrated, and contains a map showing the distribution of the shea butter tree in Northern and Western Africa, but unfortunately it is without an index.

GOUVERNEMENT GÉNÉRAL DE L'AFRIQUE OCCIDENTALE FRANÇAISE. INSPECTION DE L'AGRICULTURE. RAPPORT AGRICOLE POUR L'ANNÉE 1906. By Yves Henry. Pp. 310. (Paris : Challamel, 1907.)

This work is divided into three parts, dealing with (1) the organisation of the Agricultural Service and the conditions and work of the Agricultural and Experiment Stations in French West Africa ; (2) the natural products already exported, including ground nuts, ground nut oil, cocoa, coffee, rubber, gums, resins, copra, palm nuts, palm oil, skins and waxes ; (3) the natural products which, although not at present exported,

are suitable for exploitation, such as cotton, shea butter, wool, and ostrich feathers.

In the first part, descriptions are given of the Agricultural Station at Hann, near Dakar in Senegal, the Experiment Stations at Kulikoro and Banfora in the French Sudan, the Botanic Garden at Camayenne in French Guinea, and several experiment stations in Senegal.

The second part deals very fully with the export trade of the French West African Colonies and the conditions of the industry in the case of each article exported. Particulars are given of methods for improving the cultivation of the economic plants, and the preparation of their products for the market.

The third part gives a detailed account of experimental work carried out with the various products suitable for exploitation, and states clearly the prospects of the creation of an industry in each case.

The Report shows evidence of very careful work, and is well provided with maps and illustrations.

THE BRITISH YEAR BOOK OF AGRICULTURE, AND AGRICULTURAL WHO'S WHO, 1908–9. Pp. viii. + 582. (London: Vinton & Co., Ltd., 1908.)

This is a comprehensive and useful book of reference for those interested in agriculture, live stock and the land. It gives information as to the government departments, societies, clubs, educational institutions, markets, shows, sales, prices, publications, legal enactments and statistics that are concerned with agriculture and the allied subjects of horticulture, arboriculture and animal breeding. The objects, and the names of the officials, of the various institutions are recorded both for the United Kingdom and for the counties of England, Wales and Scotland. Foreign and Colonial information is added bearing on the regulations as to the importation of animals and on the publications issued. At the end of the work is a "Who's Who" giving an account of about 2000 persons connected with agriculture as farmers, breeders, judges or officials.

AN EXAMINATION INTO THE DIVISIBILITY OF THE BRIN OR ULTIMATE FIBRE OF THE SILK OF *BOMBYX MORI* OR SILK OF COMMERCE, AND OF SOME WILD SILKS. Pp. 99, with 35 plates. By Sir Thomas Wardle, J.P. Followed by a Monograph, "Sullo Sfilacciarsi delle Sete Tinte," being the report of a similar investigation carried out in the Laboratory of Silk Studies, Milan. Translated by Miss Kate Milner and Sir Thomas Wardle. Pp. 48, with 13 plates. (Manchester and London: John Heywood, Limited, 1908.)

These monographs deal with a curious defect which is sometimes observed in silk yarns. This defect consists of little roughnesses or inequalities which are unevenly distributed and are of a lighter colour than the rest of the material. These microscopic excrescences, which are termed "specks," "slubs" or "fiocchetti," are particularly objection-

able since they hinder the free running of the thread in weaving operations and cause it to break frequently as it passes across the comb; moreover, they depreciate the value of the material by rendering it less lustrous. Various hypotheses have been advanced to explain the nature and origin of these "specks." Careful microscopical investigation, however, has revealed the fact that they result from the formation of very fine fibrillæ, the diameter of which is about one-tenth of that of the single silk fibre.

The volume under review contains accounts of researches on this subject and indicates the causes of the defect. It has been found that all silk fibres are liable to split up into fibrillæ, but that the readiness with which this takes place depends to some extent on the variety of the silkworm, the degree of selection to which it has been subjected, the methods employed in degumming the silk and other factors. Directions are given for preventing the formation of the "specks" or of minimising their number. The record of Sir Thomas Wardle's own researches contains an account of the formation of fibrillæ in several varieties of silk, including the wild silks (*Anaphe* sp.) of Uganda and West Africa (compare this *Bulletin*, 1907, **5**. 438).

The work is provided with a large number of illustrations representing various silkworms, moths, cocoons and "specky" silk fibres.

FIBRES FOR FABRICS. By A. E. Garrett, B.Sc. Pp. xi. + 220. (London: Hodder & Stoughton, 1908.)

The author states in the preface to this volume that it is not intended to replace or even supplement literature already available dealing with the preparation of fibres and their conversion into yarns and fabrics. Rather, it is claimed to be an introduction to the study of other books on textile subjects. Regarded in this light the work will doubtless prove of considerable utility.

The author deals with the origin and production of the principal textile fibres of commerce, whilst some few non-textile fibres are casually mentioned.

A chapter is devoted to the microscopical study of fibres and one to chemical tests. The latter is perhaps somewhat outside the scope of the work, since the necessarily superficial treatment of the subject would be unlikely to interest or to be useful to those engaged in dry goods warehouses, for whom the work is primarily produced.

The volume is illustrated with sketches of fibres, as seen under the microscope, and a few diagrams of simple chemical apparatus are also included.

A TREATISE ON COLOUR MANUFACTURE. By G. Zerr and Dr. R. Rübencamp, authorised English edition by Dr. C. Mayer. Pp. xiii. + 605, with illustrations. (London: C. Griffin & Co., 1908.)

This work deals with the technology of the chief pigments used in the arts, and commences with some general remarks on the establishment

of a colour works, on the necessary water supply, machinery, etc. Following this are sections dealing with the preparation and properties of the artificial mineral pigments, and the manufacture, properties and examination of the raw materials employed. The natural earth pigments and various black pigments such as lamp black are next described, while the latter part of the book is composed of a description of the natural and artificial organic dyestuffs and of the manufacture there-rom of lake colours, the concluding chapter being devoted to an account of the uses to which colours of all classes are put.

In the introduction it is stated that in order to keep the book within reasonable compass and preserve its character as a technical handbook, much matter of purely scientific interest has had to be omitted. For the purpose in view this choice is probably a good one, and there can be no question of the utility of the volume as a practical guide to colour manufacture. Its usefulness would have been enhanced from the chemist's point of view by the inclusion of more references to patent literature.

THE TOPOGRAPHY AND GEOLOGY OF THE DISTRICT BETWEEN CAIRO AND SUEZ. By T. Barron, A.R.C.S., F.G.S. Pp. 133, with plates and diagrams. (Cairo: National Printing Co., 1907.)

This able description of an interesting district is the last work of the author, who met an early death in the Sudan.

It commences with a detailed account of the country, in which not only the orographical features, but its vegetable and animal life as well as its human inhabitants are dealt with. Then follows a description of the different formations which extend from Cretaceous to Recent, the flows, necks and intrusive sheets of basalt, and finally, the faults and folds, which, we are told, play the most important part in determining the present relief of the ground.

There are two maps, topographical and geological respectively, on a scale of about four inches to the mile, and numerous sections.

IMPERIAL GAZETTEER OF INDIA. Vols. i.–xxiv. Published under the authority of the Secretary of State for India at the Clarendon Press, Oxford, 1908.

This new edition of an important official publication will occupy twenty-six octavo volumes instead of the fourteen in which it was formerly comprised. The first four volumes, averaging about five hundred pages, are devoted to a survey of the Indian Empire as a whole, while the remainder contain detailed descriptions of the principal political divisions, towns and physical features arranged in alphabetical order.

The important subject of the spelling of Indian names has been dealt with in a somewhat summary fashion, no attempt being made to distinguish, even approximately, differences of pronunciation, however important, which are unfamiliar to the European ear. In many names

the vowels must be given the English sounds, but there is no intimation when this is the case, except the presence of double e or o.

The first volume commences with a suggestive article on the physical aspects of the country by Sir Thomas Holdich, who has some interesting allusions to the progressive desiccation of the Punjab and adjoining regions.

This is followed by Sir Thomas Holland's contribution on geology, which occupies forty-nine pages and contains a readable summary of the extensive field with which it deals. Some exception might be taken to the correlation of Indian and North American præ-Cambrian strata, but it is probable that all that is intended is a comparison in the mode of the occurrence and degree of alteration of the rocks. The succession of the fossiliferous strata is clearly given and many important problems connected with the age of the rocks and ancient geographical conditions are discussed. There is an interesting suggestion that the "exotic blocks" of the Central Himalayas have been brought into their present position by the lava flows with which they are always associated.

The chapter which deals with the meteorology of India is compiled from material contributed by Sir John Eliot. It contains a considerable amount of detail, but hardly deals adequately with the conditions that prevail in Southern India. Sir Joseph Hooker's contribution on Indian botany is full of interest as is also that on zoology by the late Dr. W. T. Blanford.

The chapter on ethnology and caste is abridged from Sir Herbert Risley's essay on caste, tribe and race in the *Report on the Census of India*, 1901. He uses the word Dravidian to include the whole of præ-Aryan population of India, and apparently assumes that this was uniform in character. There is, however, no reason to believe that the higher types of the southern tableland of the Peninsula contain any appreciable Aryan admixture, yet with their small nasal index and fine features they have nothing in common with the lower types, who would best be described as præ-Dravidian.

Mr. Grierson's contribution on the languages of India is one of the best articles in the volume. It is only too brief for the vastness of the subject. He recognises the distinction between the original speakers of the Dravidian language and the aboriginal tribes, whose speech was, he believes, allied to the present Munda dialects, which exhibit a remarkable structural resemblance to the American languages.

There is no space here to do justice to the chapter on the religions of India, or those which deal with the subjects of population, public health and vital statistics, and contain interesting comparisons between different sections of the inhabitants of India, as well as between the conditions prevailing in India and Europe.

The second volume is concerned with archæology, architecture, numismatics, literature and history. There is an almost complete absence in India of early historical records, in the ordinary sense of the term, and the description of the methods by which scattered inscriptions

and ancient coins have been made to yield a connected account of the course of events is full of interest. The volume forms an admirable text-book on the closely connected subjects of which it treats.

The third volume is devoted mainly to economic topics. The important subjects of agriculture and forestry are dealt with in the first two chapters. The third on mines and minerals is based on the new edition of the *Economic Geology of India*, which is now in course of revision by Sir Thomas Holland, and his review of the Mineral Production of India for the years 1898–1903. He anticipates a time when the mineral wealth of India will be employed in that country in the manufacture of hardware, machinery, pottery, chemicals and other mineral products, instead of being exported to Europe for the same purpose. The valuable articles on arts and manufactures, commerce, irrigation and navigation give a clear idea of the transformation that is slowly but steadily being brought about in at least the outward life and habits of the vast population of the country.

The chapter on the railways and roads of India deals almost entirely with the former, and is one of the most interesting in the volume. Although the history of railway development in India presents numerous points of resemblance to that in Europe, the conditions were in many respects peculiar, and afford evidence, if such were required, of the difficulty under which even the ablest administrators labour, of determining the real needs of the communities entrusted to them, and the lines along which a new institution will develop. The marvellous efficiency and cheapness of the postal and telegraph system in India hardly receives adequate treatment in the chapters devoted to the subject, so that the multifarious duties it undertakes and the place it occupies in the life of the people will scarcely be realised by the reader. In many respects the Indian post-office is far in advance of that of the United Kingdom.

The chapter on rents, prices and wages can be recommended for perusal by students of political economy in this country. Though the conditions differ in many respects the problems are essentially the same, and the successes and mistakes of Indian administrators are equally instructive. Curiously enough no reference is made to the hold on the land which money lenders have acquired in many localities, resulting in a state of things which is as serious as that which prevails in some of the less progressive European States. The last chapter is devoted to the subject of famine, and the measures that have gone far to alleviate the suffering that it brings in its train.

The final volume of the general portion is occupied with administration, both in the native states and British India. The subject of finance is dealt with at great length, especially that of land revenue, which plays a much more important part than in Europe.

Public works, the army and police, education, medical administration, currency and banking are dealt with fully in turn, and a considerable amount of valuable information is furnished to all who have relations with India or are interested in the development of the country.

Twenty volumes of the alphabetical portion have been issued up to the present, the last concluding with the town of Zira in the Punjab.

The articles are as a rule full and accurate, but they often overlap, and the result is a great deal of repetition, which adds considerably to the bulk of the book. In a few cases there is evidence that an article is a compilation instead of being the work of one who has a personal knowledge of the locality described.

Every volume is accompanied by the same general map of India, and in addition there are maps of the different provinces, the larger native states or groups of states, and plans of the Presidency cities.

The work will conclude with an index, and a glossary of Indian terms.

A HISTORICAL GEOGRAPHY OF THE BRITISH COLONIES. Vol. I., Canada. Part II., Historical. By Hugh E. Egerton, M.A. (Pp. viii. + 365. Oxford, Clarendon Press, 1908.)

This volume is one in the new series of the well-known *Historical Geography of the British Colonies*, by Sir C. P. Lucas, the editor of this part, and who was the author of Part i., *New France*, published in 1901.

The volume is subdivided into three "books," entitled respectively *The Separate Provinces*, *The Union*, and *The Dominion;* whilst an appendix contains lists of Governors and Premiers, and the chief dates in Canadian history.

Professor Egerton deals with the intricate matters of Canadian politics in a thoroughly interesting manner, going as far as possible "behind the scenes," and revealing the reasons and motives—public and personal—which often swayed the leading men in moulding the destinies of the great Dominion, which finally came into being on July 1, 1867. Adequate references to authorities are given at the conclusion of each chapter, to enable students to pursue their researches further.

To refer to one amongst many points of interest, the chapter on the Canadian Pacific Railway presents in a few pages an excellent summary of the great difficulties—political, financial and physical—which had to be surmounted before "this great link between east and west could be accomplished, without which the Dominion must have remained a mere geographical description, each portion leading an isolated life, without the arteries of common life blood." Sir John Macdonald and Sir Charles Tupper contributed largely to this achievement in combination with Mr. Donald Smith, now Lord Strathcona, "who risked every penny that he possessed, including what he had laid aside for his wife's old age, rather than allow himself to be defeated in his great work." Of Lord Strathcona the author writes later, "Among the builders of the empire few have such good title to the name as the veteran Scottish gentleman who now, in an honourable old age, jealously watches in London over the interests of the Dominion, in the fashioning of which he has played so leading a part."

These extracts will serve to indicate the engrosing character of the

narrative, which can be recommended to all desirous of obtaining a comprehensive survey of the making of Canada.

TWENTIETH CENTURY IMPRESSIONS OF BRITISH MALAYA. Edited by Arnold Wright and H. A. Cartwright. Pp. 959. (London, etc.: Lloyd's Greater Britain Publishing Company, 1908.)

This large volume forms one of a series, the object of which, as stated in the preface, is to give, in an attractive form, full and reliable information with reference to the outlying parts of the Empire.

In addition to dealing adequately with general topographical and historical matters, definite sections are devoted to special topics, and the editors have been fortunate in securing the co-operation of writers thoroughly well qualified to deal with their respective subjects.

Mr. L. Wray, until recently Director of Museums in the Federated Malay States, contributes the article on "Native Arts and Manufactures" (pp. 232–45) in which, with the aid of numerous illustrations, the evolution of arts and crafts amongst the aborigines and Malays is traced, and an exceedingly interesting account given of the materials employed and the mode of manufacture of various types of basket work, mats, woven cloths, embroidery, pottery, toys, boats, weapons and metal work. Although quite advanced in some handicrafts it is interesting to note, as Mr. Wray points out, that the potter's wheel, known in almost all countries from the earliest historical times, is still unknown to the Malays, whose ordinary pottery is all built up by hand, as was the practice in the British Isles in the Bronze Age.

The commercial plant products of the region are well dealt with in a series of articles (pp. 328–504). Mr. A. M. Murdoch, Conservator of Forests, describes the two predominating types of forest as consisting of (1) timber and gutta-percha trees; (2) mangroves. The latter are not utilised to any extent at present. In the evergreen forests there are several valuable timber trees, but difficulties as regards transport are considerable, and the great local demand for two of the best woods, Merbau (*Afzelia palembanica*) and Chengai (*Balanocarpus maximus*), has caused a rise in price.

Mr. H. N. Ridley, F.R.S., Director of the Botanic Gardens, Singapore, deals with the Malayan flora as a whole. He points out how distinct it is from that of India and Ceylon on the one hand, and Siam and Cochin China on the other, and attributes this in part to the complete absence of seasons and the continual humidity of the Malayan Peninsula.

The article on Agriculture is contributed by Mr. R. Derry, Assistant Superintendent of the Botanic Gardens, who gives amongst other information historical notes on the gardens and the introduction of new plants. Rubber, the cultivation of which is attracting so much attention in Malaya, is dealt with by Mr. J. B. Carruthers, Director of Agriculture in the Federated Malay States, who traces the development of the industry and gives some practical notes on the methods and cost of opening up and bringing into bearing a rubber estate. This same

subject is dealt with in greater detail by Mr. Francis C. Roles, and his remarks on practical considerations in estate work, labour, and the detailed financial estimate of working expenses and returns are of considerable value. Notes on many of the chief rubber estates follow, profusely illustrated with views of new and matured estates, planters' houses, and other scenes of interest. Coconut cultivation, by Mr. L. C. Brown, the Inspector of Coconut Plantations, and a short account of the pine-apple industry concludes this portion on plant products.

Amongst other sections of scientific or commercial interest we might mention those on Mining and the Geology of the country, the latter by Mr. Scrivenor, Government Geologist, and the article on the Fauna by Mr. H. C. Robinson, Curator of the Selangor Museum.

The book is profusely illustrated throughout, and should prove of great service to all desirous of obtaining information about one of the most interesting portions of the British Empire.

DR. JAMESON, by G. Seymour Fort. Pp. vii. + 312. (London: Hurst and Blackett, 1908.)

It is important that a Life of Dr. Jameson should be written, and no one is better qualified to write it than Mr. Seymour Fort. In this country Dr. Jameson is still regarded by many only as the discredited author of a brilliant mistake. Mr. Fort deals with this difficult subject, the principal incident in Dr. Jameson's life, with much tact and judgment. The incident has long been closed and may well be forgotten here, as it has been in South Africa, and the man judged by his many achievements before and since, which culminated in his choice as Premier of Cape Colony and his position to-day as a foremost worker in the cause of South African Union. The career of the intrepid young doctor who went out to Kimberley and was attracted by Cecil Rhodes into a political career will be read by all who care for the personal history of the pioneers of Empire. In connection with Dr. Jameson's life there is much in the book that is new and interesting about his life-long friend, Cecil Rhodes.

Mr. Fort may be congratulated on having produced a most readable sketch of one who is likely in the future to play an important part in the Imperial affairs of South Africa.

COLONIAL AND INDIAN COLLECTIONS.

BARBADOS EXHIBITS.

BARBADOS, the most easterly of the West Indian islands, is situated in latitude 13° 4′ N. and longitude 59° 37′ W. It is 21 miles long, 14 miles broad, and contains an area of about 166 square miles, slightly greater than that of the Isle of Wight, which is 145 square miles.

The general aspect of a great portion of the island is of comparatively low, rounded hills, at times with well-marked terraces indicating former shore lines. The north-eastern area is of a different and more rugged character, and is known as the Scotland district. Here occur the deep-sea deposits of infusorial earth, the manjak mines, petroleum springs, and, in Turner's Hall wood, the last remnant of the forest, which formerly covered the island.

The island, other than the Scotland district, is made up of coral limestone, and coral reefs are present off the shore. This coral limestone is very porous, and the rain readily percolates through it, so that streams are scarce above ground, but subterranean streams occur, and are utilised as sources of drinking water. The underground circulation of water has played its part in the formation of the picturesque gullies so frequent on the western side, and in which alone some useful plants, unsuited to the open wind-swept country, can be cultivated.

Barbados lies in the track of the trade winds, which blow with considerable force and great persistence during the early months of the year, and help materially to moderate the heat of the dry season, whilst at the same time they are of service in turning the windmills on sugar estates. The climate is very agreeable; the mean temperature is about 75° F., and the annual rainfall about 65 inches.

The principal products of the colony are sugar, which has been a staple crop since the seventeenth century, molasses and rum, obtained as by-products in sugar manufacture; and cotton, successfully introduced during recent years. Yams and sweet potatoes are cultivated for home consumption, and for export to neighbouring islands. A promising industry in the "Canary banana" is in abeyance owing to lack of proper shipping facilities. The fishing industry is of local importance, and the colony possesses small mineral resources in the form of manjak, petroleum and infusorial earth.

VEGETABLE PRODUCTS.

Sugar Cane (*Saccharum officinarum*).—The sugar industry of Barbados dates from about the middle of the seventeenth century. At first other products were also grown on a considerable scale, but the large profits

obtained from sugar comparatively soon made it the staple crop of the Colony, a position which it still retains, although recently, following the depressed state through which the sugar industry has passed, the cultivation of cotton has been revived with marked success. The total area used for sugar cane in the island is approximately 60,000 acres, but in any one year a large proportion, perhaps nearly one-half, is under rotation crops, or undergoing preparation for the next year's crop.

Barbados, owing to the investigations of Prof. J. B. Harrison and Mr. J. R. Bovell, shares with Java the credit of discovering sugar cane seedlings, and their work in 1886 was the starting-point of the lengthy series of researches on sugar cane seedlings since actively prosecuted. New seedlings raised in Barbados are designated by the letter "B" and a numeral, thus: B. 147; B. 208, to mention two now known in many parts of the world.

Many of the sugar estates are of very small acreage and are equipped with primitive machinery, the mode of preparation being the same as was practised in the seventeenth century. The trade-winds blow steadily during the crop season, and on such estates windmills, so characteristic a feature of the island, are used to furnish power to crush the canes. On the larger estates, however, modern machinery and appliances have been introduced, and steam has superseded the wind as the chief motive power.

The annual crop is about 55,000 tons of sugar, and about the same number of puncheons (each 100 gallons) of molasses. The sugars principally made in Barbados are muscovado, and various grades of yellow and white crystal sugars.

EXHIBITS—

Sugar Canes. Dried specimens of mature canes as cut for sugar production.

Clarified Cane Juice. The juice of the cane after clarification but before undergoing evaporation to a syrup.

Sugar Cane Syrup. The syrup resulting from the evaporation of the clarified juice.

Masse-cuite. Sugar cane syrup, if sufficiently evaporated, sets on cooling into a mass consisting of sugar crystals and molasses and known as masse-cuite. The molasses can be separated from the sugar crystals by simple drainage or in other ways.

Muscovado Sugar. The old-fashioned brown or moist sugar, made by evaporating the syrup in open boiling pans, granulating in cooling tanks, and "curing" by allowing the molasses to drain away from the masse-cuite placed in perforated hogsheads or bags.

Centrifugal Muscovado Sugar. Prepared as the above but "cured" in centrifugal machines instead of by ordinary drainage

Oscillated Muscovado Sugar. Prepared as ordinary muscovado sugar, but the mass when sufficiently concentrated for crystallisation is subjected to treatment in oscillators—troughs with revolving paddles—before being transferred to the coolers.

Centrifugal Oscillated Muscovado Sugar. Prepared as the preceding, but cured in centrifugal machines instead of by simple drainage.

Syrup Sugar. This name has now gone out of use to a considerable extent, but it indicates vacuum pan sugars prepared from the syrup or concentrated juice as distinct from "molasses sugars" crystallised from the molasses obtained by centrifugal treatment of the syrup sugars.

Dark Crystal Sugar.
White Crystal Sugar.
Yellow Crystal Sugar.
} Crystal sugars produced in vacuum pans.

Muscovado Molasses. The uncrystallised sugars remaining after the removal of the sugar crystals from the product prepared in open boiling pans.

Crystal Sugar Molasses. Molasses remaining after preparation of crystal sugars in vacuum pans.

Megass. The crushed cane left after extraction of the juice. It is of great importance locally as fuel for evaporating the syrup.

Molascuit. A cattle food made by saturating the finer megass with molasses.

Rum. Prepared from molasses by fermentation and subsequent distillation. Rums as distilled are colourless (white rum), but are usually coloured by the addition of small quantities of burnt sugar, etc.

White Rum. (66° over proof.)

Coloured Rum. (Proof.)

Liqueurs, etc.

Falernum.

White Falernum.

Cherry Falernum.

Wormwood Bitters—flavoured by a species of *Artemisia.*

Orange Bitters.

Sorrel Bitters—flavoured by the Roselle or Sorrel (*Hibiscus Sabdariffa*).

Models of cattle and mule carts as used on estates for conveying cut sugar canes, hogsheads of sugar, puncheons of molasses, manure and general produce.

Cotton.—In the seventeenth century cotton was one of the chief products of Barbados, but subsequently the cultivation of this crop

was abandoned for that of sugar, which then gave far more profitable returns. In 1902 the industry was revived on the initiative of the Imperial Department of Agriculture, and a supply of specially selected seed of Sea Island cotton was obtained from the United States. The effort was very successful, and the value of the crop rose from £318 in 1902–3 to £76,876 in 1906–7.

Exhibits—

Sea Island Cotton. Seed Cotton.
" " " Lint.
" " " Seed.
Egyptian Cotton, variety Mitafifi. Lint.
" " " Abassi. Lint.

Cassava (*Manihot utilissima*).—The cassava plant is largely cultivated and is of importance locally, as in other tropical countries, as a food-stuff. The roots may be cooked and eaten as a vegetable, or cassava meal or farine and cassava starch or flour prepared from them. The farine is sometimes made up into cassava cakes. Casareep, an important ingredient in many sauces, is made by boiling down the latex or milky juice which is expressed from the pounded roots in the preparation of farine.

Exhibits—

Cassava Meal or Farine.
" Starch or Flour.
" Cakes.

Maize or Indian Corn (*Zea Mays*).—Maize is cultivated on a moderate scale, but not sufficiently to supply the local demands as a cattle food and for human consumption.

Exhibits—

Maize Cobs.
Maize.

Pigeon Peas (*Cajanus indicus*).—A shrubby plant extensively grown for the sake of its seeds which, cooked in various ways, are an important article of diet, especially amongst the negro population. The young peas make a moderate substitute for the ordinary green pea. Amongst other names are "no-eye peas" and, in India especially, "dhal."

Exhibits—

Pigeon Peas.

Ground Nuts (*Arachis hypogea*).—On the light soils in the dry eastern portion of the island there is a minor industry in the cultivation of ground nuts, the seeds of which are usually eaten when parched,

or made up into sweetmeats. The seeds are not used as a source of oil in Barbados. The trailing leafy shoots remaining after the crop of nuts is gathered are made into hay.

Exhibits—

Ground Nuts in shell.
Ground Nuts shelled and parched.

Arrowroot (*Maranta arundinacea*).—In the north-eastern, or "Scotland," district of Barbados the cultivation of arrowroot is carried on to a moderate extent, and the starch is prepared for use as a food-stuff and for laundry purposes. The quantity produced is, however, insufficient to supply the local demands.

Exhibits—

Arrowroot Starch.

Tous-les-Mois (*Canna edulis*).—This plant is grown to a small extent for the sake of the starch, somewhat resembling arrowroot, obtained from its underground stems.

Exhibits—

Tous-les-Mois Starch.

Coconuts (*Cocos nucifera*).—Coconuts are grown to a very limited extent and the nuts produced are used locally.

Exhibits—

Coconuts, whole and in section.

Cashew Nuts (*Anacardium occidentale*).—The cashew nut is a small tree, which is commonly cultivated in Barbados and is practically wild in places in the "Scotland" district. The "nuts" or kernels form an excellent article of dessert when properly roasted.

Exhibits—

Cashew Nuts in shell.
Cashew Nuts parched and shelled.

Aloes (*Aloe vera*).—The drug aloes consists of the dried sap of various species of aloe, succulent plants belonging to the *Liliaceæ*. Barbados aloes is obtained from *Aloe vera*, introduced at an early date into the West Indies. The cut leaves are placed in sloping troughs, and the juice readily runs out and is collected in a vessel. It is then evaporated to the proper consistence and ladled into gourds or boxes in which on cooling it consolidates into a hard, black mass. Varying quality in the product led to the decline of the industry in Barbados,

where aloes are cultivated now only on a very small scale. Curaçoa (Dutch West Indies) produces most of the "Barbados aloes" which comes into the market.

Exhibits—

Aloes in gourd.
Aloes.
Photographs illustrating aloe cultivation.

Chillies and Cayenne Pepper (*Capsicum* spp.).—The various species of Chillies or peppers commonly cultivated in gardens. The different varieties vary much in pungency. Some are eaten raw or cooked with food, or dried and ground, converted into cayenne pepper; pickles, stuffed peppers and sauce are other uses.

Exhibits—

Cayenne Pepper.
Green Negro Peppers.
Stuffed Peppers.

Preserves and Pickles.—Made for domestic consumption.

Exhibits—

Candied Rind of the Shaddock (*Citrus decumana*), a fruit resembling a huge orange, at times 8 to 10 inches in diameter. The shaddock is the same as the Indian pomelo, but was introduced into the West Indies by Captain Shaddock, hence the local name.
Shaddock Marmalade.
Candied rind of the Grape Fruit, a smaller variety of the above.
Preserved Limes (*Citrus medica*, var. *acida*), widely cultivated in the tropics, and especially in the West Indies.
Guava Jelly and Guava Marmalade, made from the fruits of Guava (*Psidium Guajava*), a West Indian plant.
Gooseberry Jam, made from the so-called Barbados gooseberry (*Cicca disticha*), a small tree belonging to the Spurge order (*Euphorbiaceæ*) bearing pleasantly acid fruits.
Tamarinds, the fruits of a large tree (*Tamarindus indica*) native to the East Indies and now found in most parts of the tropics. The pulp of the fruits is a mild laxative.
Pickled Cabbage Palm, the pickled young flower-shoots of the cabbage palm (*Oreodoxa oleracea*).
Pickled Onions and Eschalots.
Mango Chutney.
Hot Sauce.
Salmi Gundi.

Ornamental Seeds.—Throughout the West Indian Islands various plants bearing ornamental, often highly coloured, seeds occur. The seeds are used in making fancy articles.

Exhibits—

Circassian Seeds (*Adenanthera pavonina*).
Castor Oil Seeds (*Ricinus communis*).
Crabs' Eyes (*Abrus precatorius*).
Nicker Seeds (*Cæsalpinia Bonducella*).
Job's Tears (*Coix Lachryma-Jobi*).
Horse Eye Beans (*Mucuna urens*).
Lenten Beans (*Erythrina indica*).
Good Luck Seeds (*Thevetia neriifolia*).
Flamboyant Seeds (*Poinciana regia*).
Moabites (*Pithecolobium Unguis-cati*).
Mimosa Seeds (*Leucæna glauca*).
Ebony Seeds (*Albizzia Lebbek*).
Tamarind Seeds (*Tamarindus indica*).
A general collection of ornamental seeds.

Basket Work.—Baskets for household use, marketing and for use on estates are made.

Exhibits—

Various specimens of basket work.

ANIMAL PRODUCTS.

Flying Fish. The flying fish (*Excœtus Roberti*) is extensively used in Barbados as an article of diet. It is caught by fishermen usually at from 5 to 10 miles from land. The fish is of good flavour, and is in demand amongst all classes.

Exhibits—

Flying Fish (*Excœtus Roberti*).
Flying Fish Net.
Model of a Flying Fish Boat.

Sea Eggs. A species of Sea Urchin (*Echinus esculentus*) is collected from the various reefs off the island. The fishermen dive from anchored boats, and with a piece of bent iron scrape the echinoderms into small nets. The roes are eaten, and are in large demand.

Exhibits—

"Sea Eggs."

Craw Fish (*Pelæmon Jamaicensis*).

Miscellaneous Fisheries Exhibits—

Model of a "Moses," a local name for a particular build of rowing boat.
Fish Pots.

MINERAL PRODUCTS.

Manjak. This material, also known as glance pitch, is a purer form of bitumen than the ordinary asphalt. Manjak occurs in Barbados in irregular seams and pockets in various localities in the Scotland district. It has been worked since about 1896, and is chiefly exported to the United States, to be used in the manufacture of Brunswick black, and as an insulating material for electric cables (see this *Bulletin*, 1904, **2.** 183).

Exhibits—

Large block of Manjak.
Manjak.

Petroleum. Petroleum occurs also in various localities in the Scotland district, and its presence is often noticeable in the small rivers and streams in this neighbourhood. The crude oil is usually black and tarry or deep brown, owing to the presence of bitumen. A green oil is also obtained. For many years the crude oil has been used in Barbados and other islands as a dressing for wounds and skin diseases, etc., and for internal application. More recently it has been employed as a fuel and lubricant (see this *Bulletin*, 1904, **2.** 182).

Exhibits—

Bituminous Oil.
Liquid Bitumen.
Crude Petroleum.
Crude Green Tar.
Crude Liquid Asphalt.
Refined Liquid Asphalt.

Infusorial Earth. In the Scotland district occur fairly large deposits of infusorial earth, old deep-sea deposits comprised mainly of the siliceous remains of minute marine organisms, but they are not at present extensively worked. Infusorial earth is of use as a non-conducting layer for packing boilers (see this *Bulletin*, 1905, **3.** 88).

Exhibits—

Infusorial Earth, in lumps and crushed.

Ochreous Clays occur in Barbados, but are of little economic interest.

Exhibits—

Ochreous Clays.

Pottery. Some of the clays of the Scotland district are made into pottery for local use.

Exhibits—

Pottery of various types: water coolers, flower pots, kitchen utensils and ornamental articles.

Volcanic Dust. In the course of the eruption of the Soufrière in St. Vincent, in 1872 and again in 1902, Barbados was visited by dense showers of fine volcanic dust, although it is some 90 miles distant from the volcano. The first dust shower of 1902 formed a layer of about ½ an inch thick, and it was calculated 2,000,000 tons of material fell on the island. The dust proved on analysis to be mainly silica, and consequently of but little fertilising value. Two similar but lighter falls occurred at subsequent eruptions in the same year.

Exhibits—

Volcanic Dust collected in Barbados from St. Vincent eruptions of 1872 and 1902.

MISCELLANEOUS.

Royal Presents. Lent by H.M. the King.

An Address in carved cabinet of native woods, presented to Her Majesty Queen Victoria on the occasion of the Jubilee of her reign in 1887.

Maps

Admiralty Chart, 1873.
Geological Map (by J. B. Harrison and A. J. Jukes Browne).

Photographs.

Two large frames containing 21 general views.
Large framed views of—
- Newcastle Sugar Estate.
- Joe's River.
- Bridgetown Harbour.
- Government House.
- Typical Estate House.

LIBRARY.—RECENT ADDITIONS

Books, etc., exclusive of periodical Government Publications, presented to the Library of the Imperial Institute since September 10, 1908.

India.

Report of the Committee of the Bengal Chamber of Commerce for the year 1907. Vol. ii. Documents and Correspondence . . . . (*The Secretary.*)

The Imperial Gazetteer of India. Vols. xv.–xxiv. . . . . (*The Secretary of State for India.*)

The Commercial Products of India. Being an abridgment of *The Dictionary of the Economic Products of India* . By Sir George Watt, C.I.E. M.B., C.M., LL.D. (Abd. and Glasg.), F.L.S. (*The Secretary of State for India.*)

Straits Settlements.

Twentieth Century Impressions of British Malaya: Its History, People, Commerce, Industries and Resources . (*The Crown Agents for the Colonies.*)

New Zealand.

Transactions of the New Zealand Institute, 1907 . . . . (*The Secretary.*)

Canada.

McGill University Examination Papers, 1907–1908 . . . . . . (*The Secretary.*)

Documentary History of Education in Upper Canada. Vols. xxiii. 1871–1872, xxiv. 1872, xxv. 1871–1874. . . By J. George Hodgins, I.S.O. M.A., LL.D. (*The Minister of Education.*)

United Kingdom.

Transactions of the Institution of Mining and Metallurgy. Vol. xvii. 1907–1908 (*The Secretary.*)

The Libraries of London: A Guide for Students . . . . By Reginald Arthur Rye. (*Goldsmith's Librarian, University of London.*)

Report on the Results of the Chemical and Bacteriological Examination of the London Waters, 1908 . . .	(*Metropolitan Water Board.*)
Transactions of the Institution of Naval Architects, 1908	(*The Secretary.*)
University College Calendar, Session 1908–1909	(*The Provost.*)
The Incorporated Accountant's Yearbook, 1908–1909	(*The Secretary.*)
Calendar of the University of London, 1908–1909	(*The Registrar.*)
Proceedings of the Royal Society of Edinburgh, Volume xxviii., Parts 7 and 8	(*The Secretary.*)
Kalendar of the Royal Institution of British Architects, Nov. 1908—Oct. 1909 .	(*The Secretary.*)

Miscellaneous.

De Looistoffen: Botanisch-Chemische Monographie der Tanniden . .	By Dr. J. Dekker. (*Dr. Greshoff.*)
Hevea brasiliensis, or Para Rubber, its Botany, Cultivation, Chemistry and Diseases	By Herbert Wright, A.R.C.S. F.L.S. (*Messrs. MacLaren & Sons.*)
Specifications for Decorators' Work: A Guide to Architects, Engineers, Property Owners, Estate Agents, House Painters, and others	By Frederick Scott-Mitchell.
Fruit Trees and their Enemies, with a Spraying Calendar	By Spencer Pickering, M.A., F.R.S., and Fred. V. Theobald, M.A. (*Messrs. Simpkin, Marshall, Hamilton, Kent & Co.*)
The Future of Cacao Planting . .	By Harold Hamel Smith. (*The Author.*)
On Brewing: Five popular lectures .	By Dr. Emil Westergaard. (*Royal Scottish Society of Arts.*)

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Botanical and Zoological names, as well as Titles of Books reviewed, are printed in italics.

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